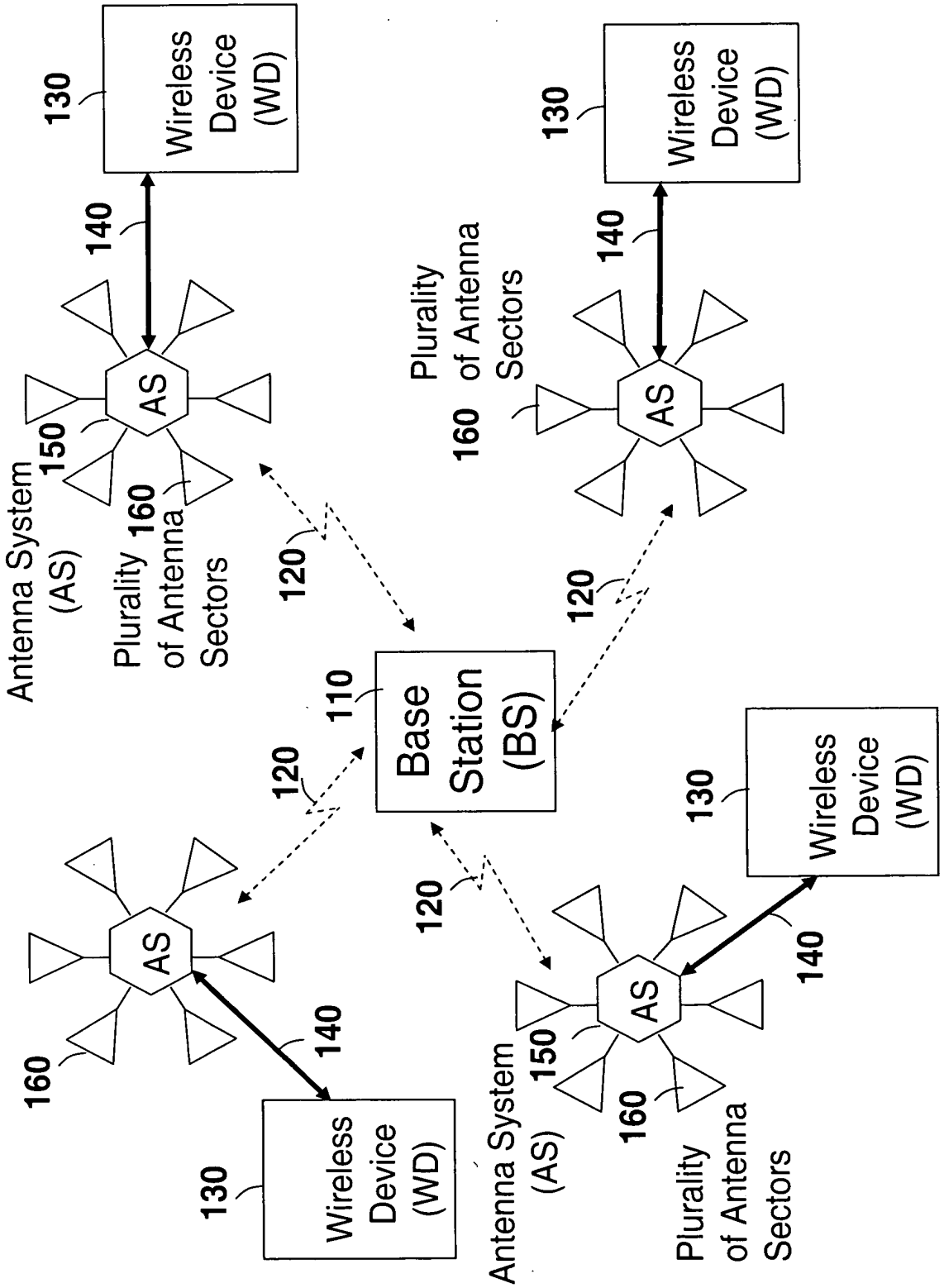

Base Station (BS)
110
120
AS
Antenna System (AS)
150
Plurality of Antenna Sectors
160
Wireless Device (WD)
130
140

Fig. 1

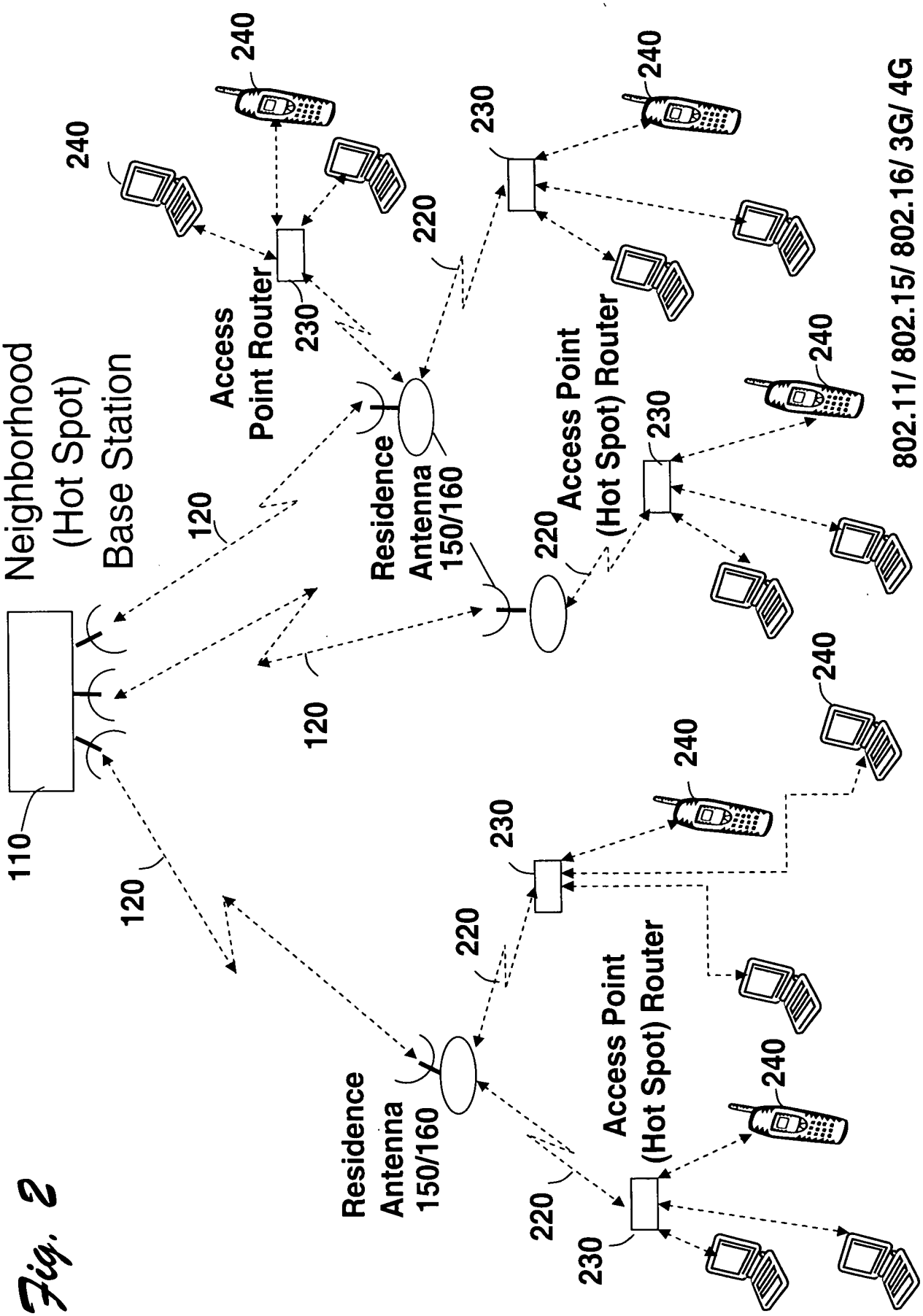
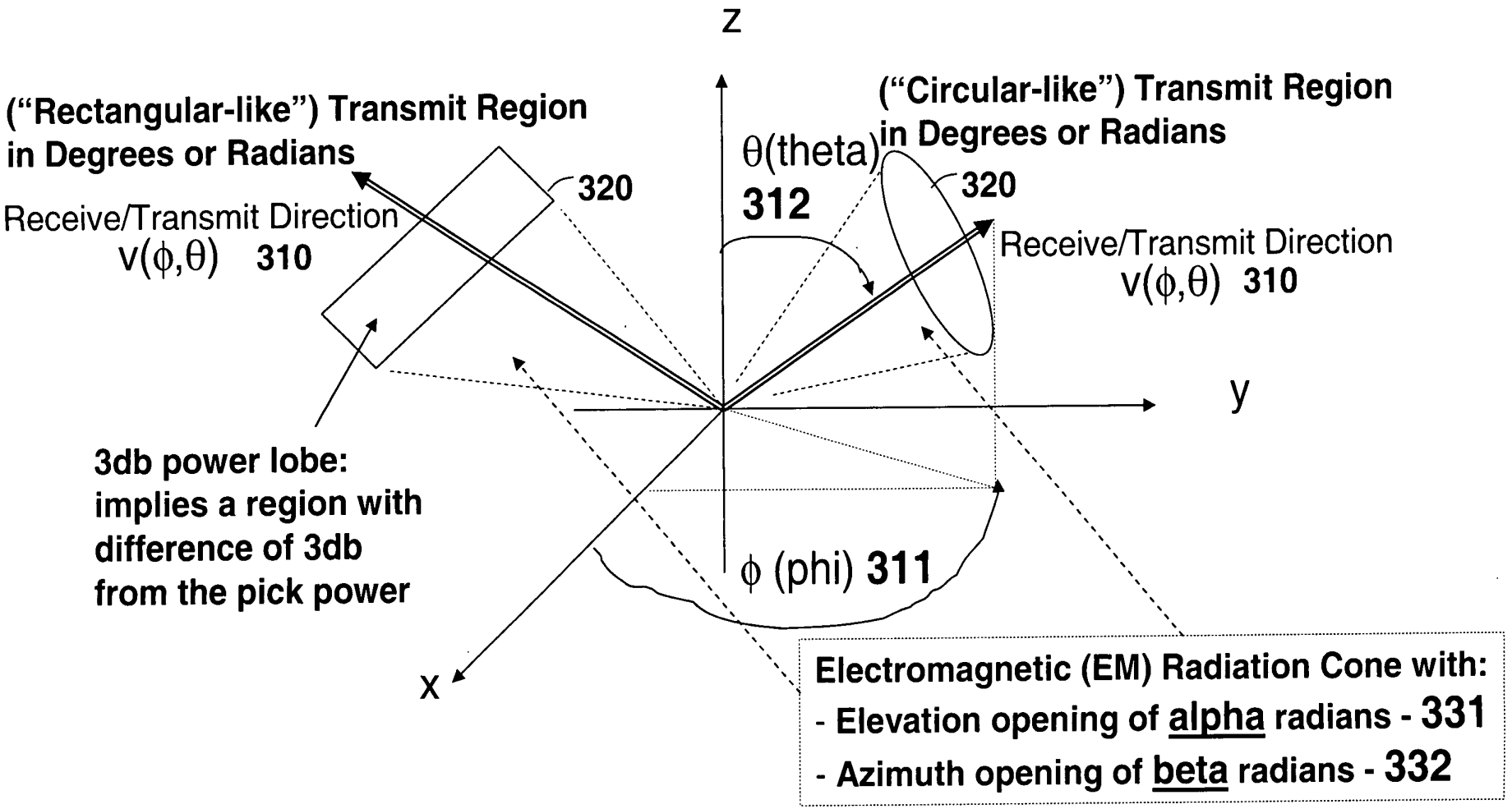

Neighborhood
(Hot Spot)
Base Station
110
120
120
120
Access
Point Router
230
Residence
Antenna
150/160
220
Access Point
(Hot Spot) Router
230
220
Residence
Antenna
150/160
220
Access Point
(Hot Spot) Router
230
220
230
240
802.11/ 802.15/ 802.16/ 3G/ 4G

Fig. 2

Fig. 3

Each Antenna Sector **160** is Defined by:

1. Receive/Transmit **Direction** in 3D (Three Dimensional) Space, and
2. Receive/Transmit **Region**
   (the region perpendicular to the Receive/Transmits Direction in a defined distance)



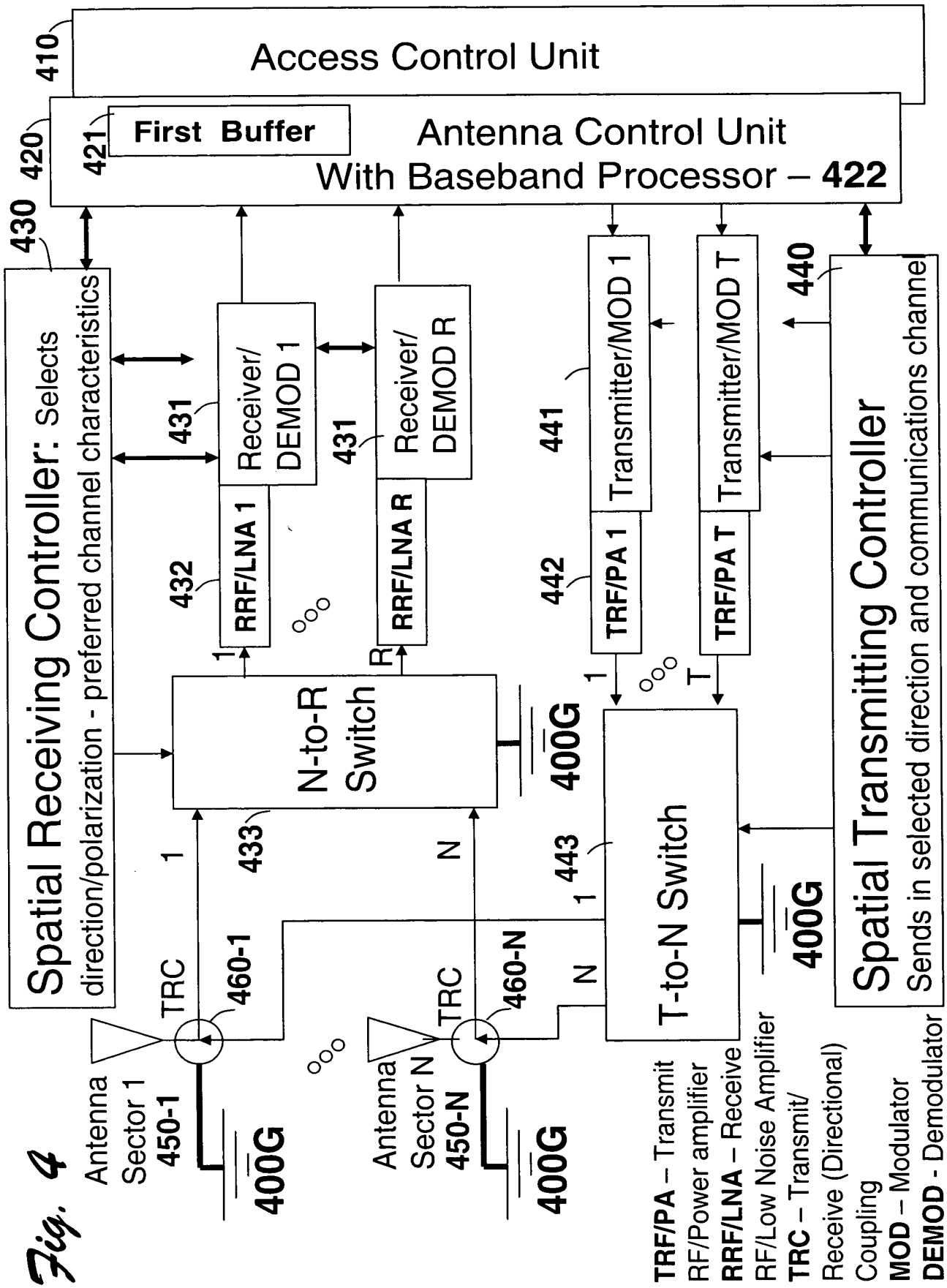

Access Control Unit
410
Antenna Control Unit
With Baseband Processor – 422
420
First Buffer
421
Spatial Receiving Controller: Selects
direction/polarization - preferred channel characteristics
430
Receiver/
DEMOD 1
Receiver/
DEMOD R
431
431
RRF/LNA 1
RRF/LNA R
432
N-to-R
Switch
433
Transmitter/MOD 1
Transmitter/MOD T
441
TRF/PA 1
TRF/PA T
442
T-to-N Switch
443
Spatial Transmitting Controller
Sends in selected direction and communications channel
440
TRC
460-1
460-N
Antenna
Sector 1
450-1
Antenna
Sector N
450-N
400G
400G
400G
TRF/PA – Transmit
RF/Power amplifier
RRF/LNA – Receive
RF/Low Noise Amplifier
TRC – Transmit/
Receive (Directional)
Coupling
MOD – Modulator
DEMOD - Demodulator

Fig. 4

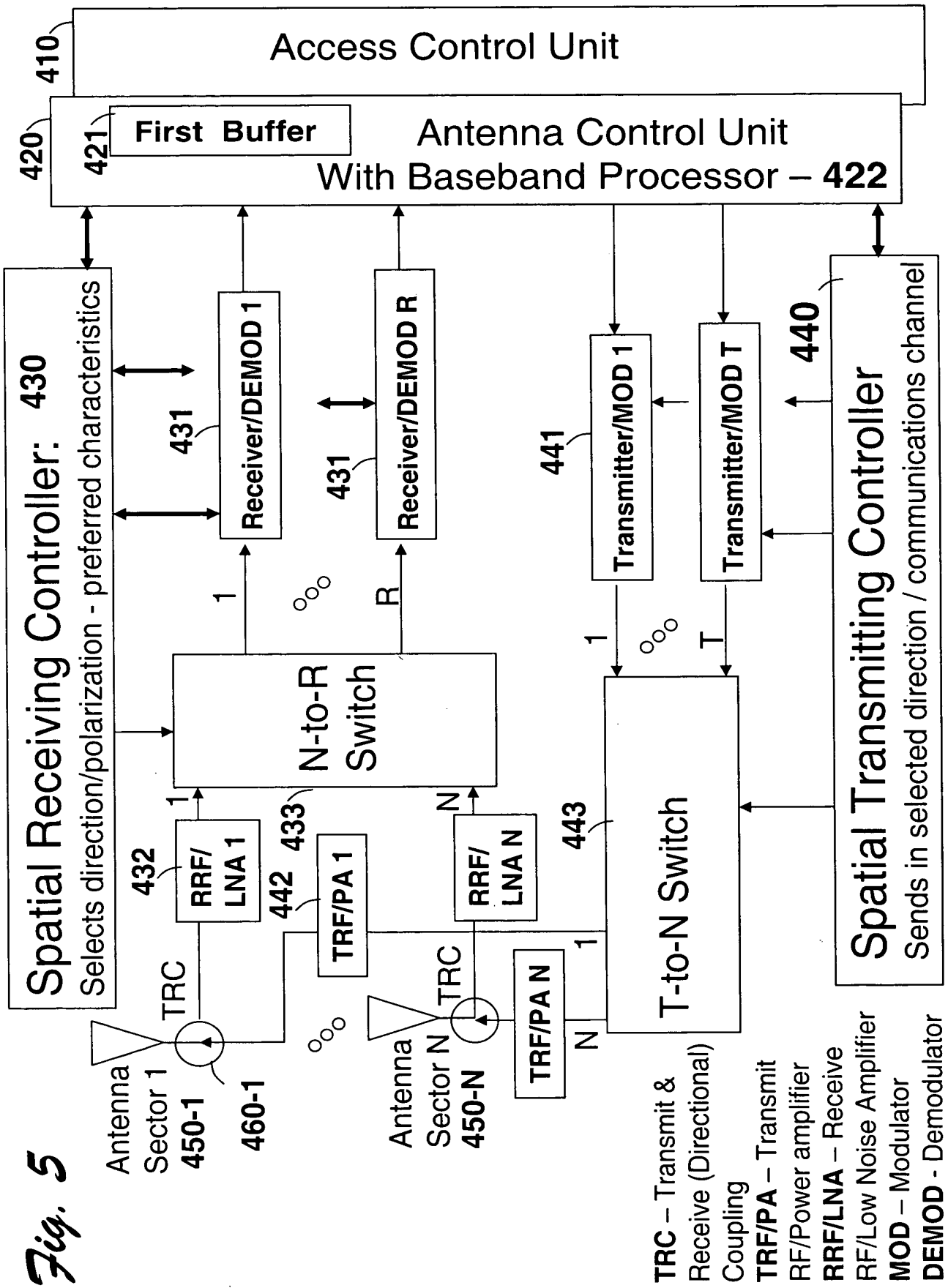
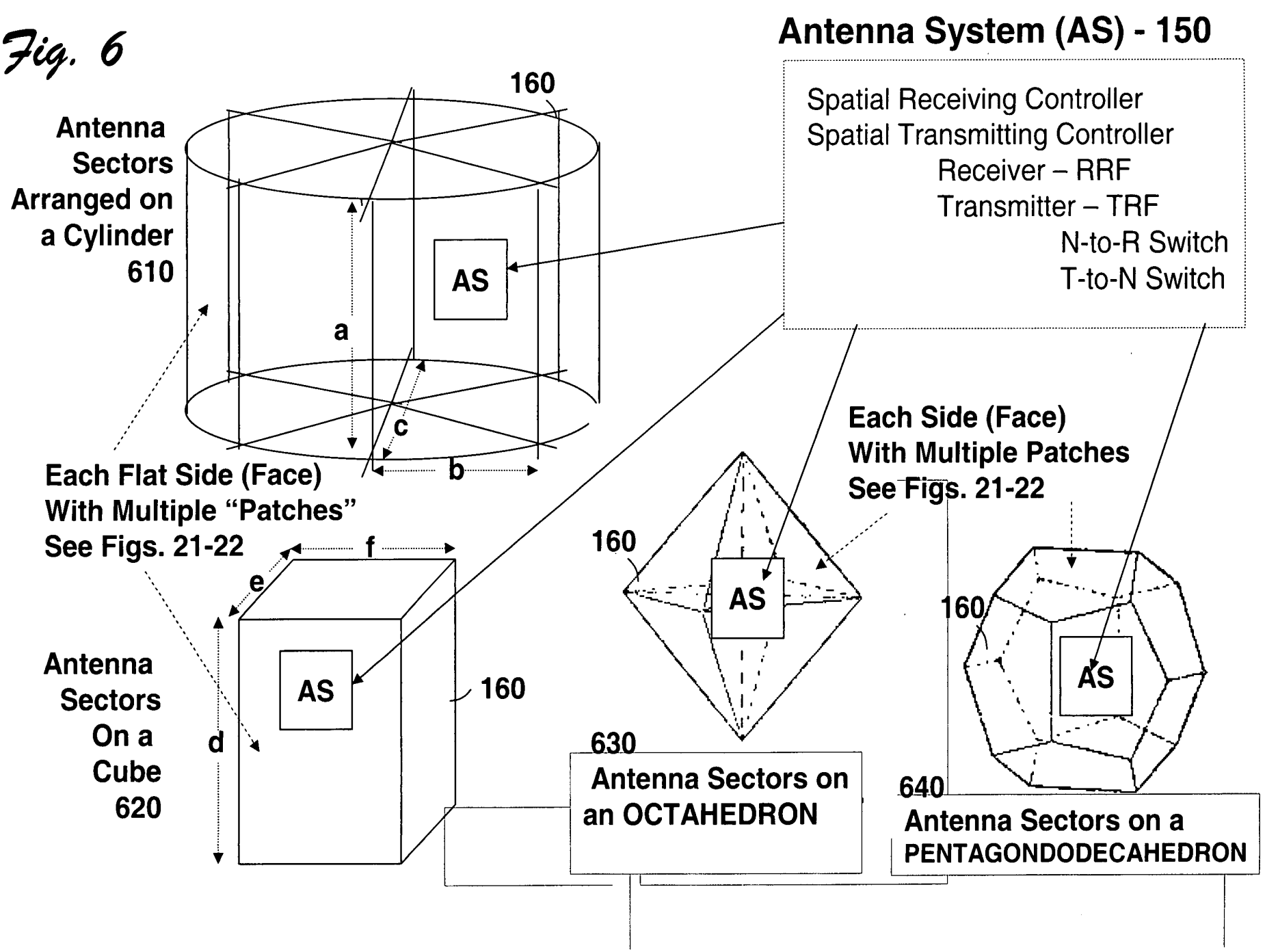

Access Control Unit
410
420
421
First Buffer
Antenna Control Unit
With Baseband Processor – 422
Spatial Receiving Controller: 430
Selects direction/polarization - preferred characteristics
Receiver/DEMOD 1
Receiver/DEMOD R
431
431
Transmitter/MOD 1
Transmitter/MOD T
441
440
Spatial Transmitting Controller
Sends in selected direction / communications channel
N-to-R Switch
T-to-N Switch
443
RRF/ LNA 1
RRF/ LNA N
432
433
TRF/PA 1
TRF/PA N
442
TRC
TRC
Antenna Sector 1 450-1
460-1
Antenna Sector N 450-N
1
R
1
T
1
N
N
1
N
TRC – Transmit & Receive (Directional) Coupling
TRF/PA – Transmit RF/Power amplifier
RRF/LNA – Receive RF/Low Noise Amplifier
MOD – Modulator
DEMOD - Demodulator

Fig. 5

Fig. 6


Antenna System (AS) - 150
Spatial Receiving Controller
Spatial Transmitting Controller
Receiver – RRF
Transmitter – TRF
N-to-R Switch
T-to-N Switch
Antenna Sectors Arranged on a Cylinder 610
160
AS
a
b
c
Each Flat Side (Face) With Multiple "Patches" See Figs. 21-22
e
f
d
Antenna Sectors On a Cube 620
Each Side (Face) With Multiple Patches See Figs. 21-22
630
Antenna Sectors on an OCTAHEDRON
640
Antenna Sectors on a PENTAGONDODECAHEDRON

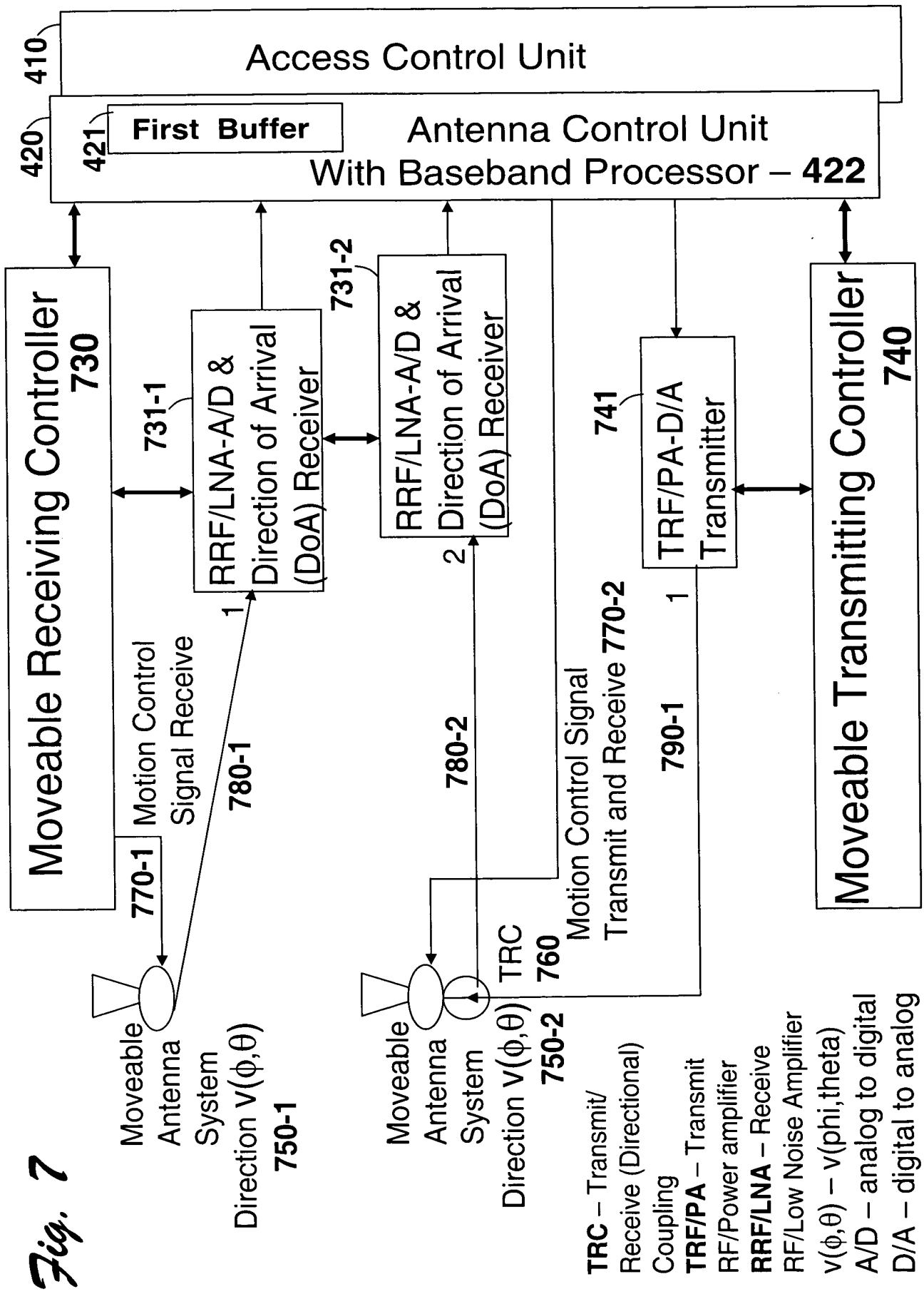
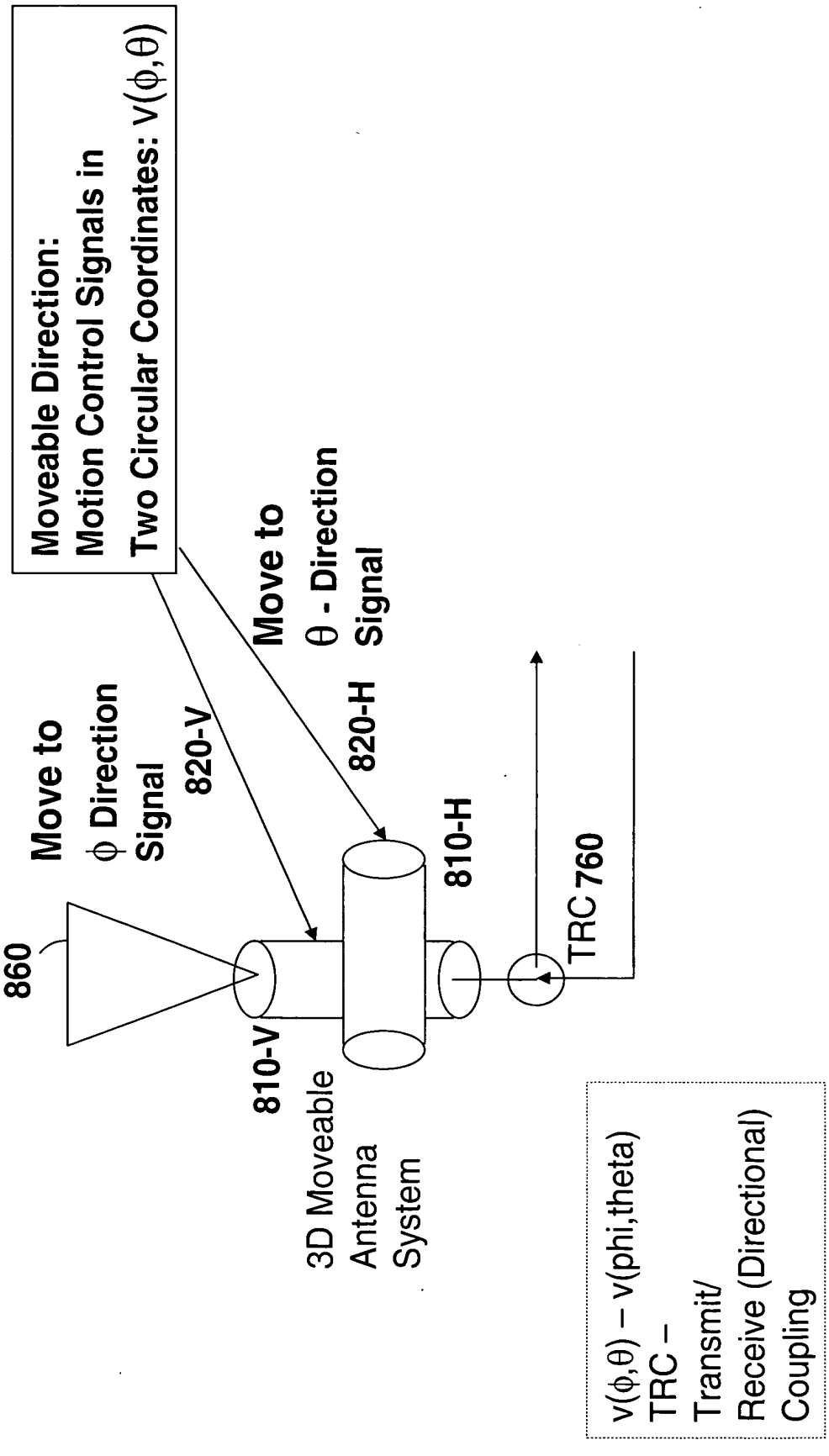

Access Control Unit
410
First Buffer
421
Antenna Control Unit
With Baseband Processor – 422
420
Moveable Receiving Controller
730
731-1
RRF/LNA-A/D &
Direction of Arrival
(DoA) Receiver
731-2
RRF/LNA-A/D &
Direction of Arrival
(DoA) Receiver
741
TRF/PA-D/A
Transmitter
Moveable Transmitting Controller
740
Motion Control
Signal Receive
770-1
780-1
780-2
790-1
Motion Control Signal
Transmit and Receive 770-2
TRC
760
Moveable
Antenna
System
Direction V(ϕ,θ)
750-1
Moveable
Antenna
System
Direction V(ϕ,θ)
750-2
1
2
1
TRC – Transmit/
Receive (Directional)
Coupling
TRF/PA – Transmit
RF/Power amplifier
RRF/LNA – Receive
RF/Low Noise Amplifier
v(ϕ,θ) – v(phi,theta)
A/D – analog to digital
D/A – digital to analog

Fig. 7

Fig. 8


Antenna System (AS) – 750
(step-motor / electric motor / electric field)
Moveable Direction:
Motion Control Signals in
Two Circular Coordinates: v(ϕ,θ)
Move to
ϕ Direction
Signal
820-V
Move to
θ - Direction
Signal
820-H
860
810-V
3D Moveable
Antenna
System
810-H
TRC 760
v(ϕ,θ) – v(phi,theta)
TRC –
Transmit/
Receive (Directional)
Coupling

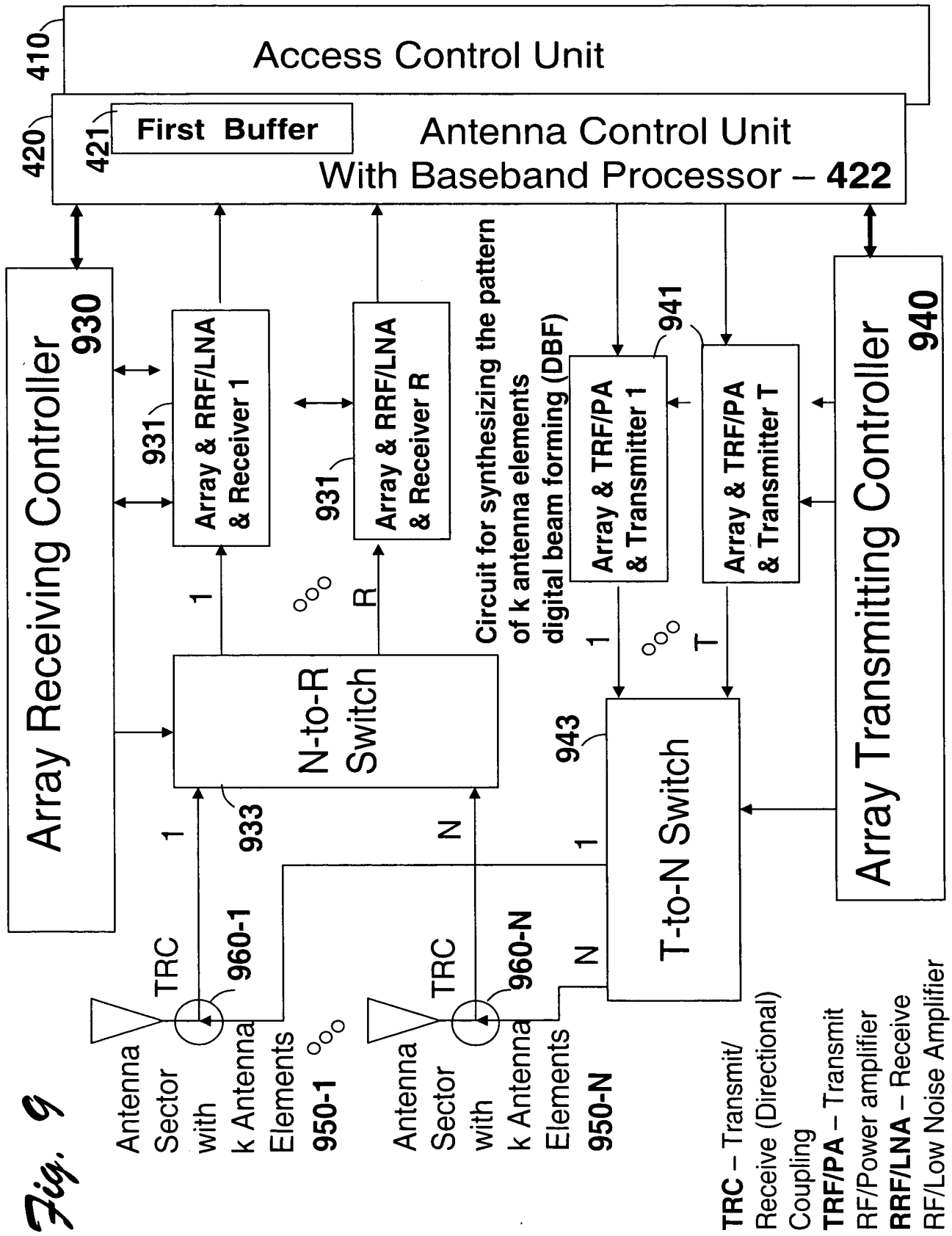

Access Control Unit
410
First Buffer
421
Antenna Control Unit
With Baseband Processor – 422
420
Array Receiving Controller
930
Array Transmitting Controller
940
Array & RRF/LNA & Receiver 1
931
Array & RRF/LNA & Receiver R
931
Array & TRF/PA & Transmitter 1
941
Array & TRF/PA & Transmitter T
Circuit for synthesizing the pattern of k antenna elements digital beam forming (DBF)
N-to-R Switch
933
T-to-N Switch
943
1
R
1
T
1
N
1
N
TRC
960-1
TRC
960-N
Antenna Sector with k Antenna Elements
950-1
Antenna Sector with k Antenna Elements
950-N
TRC – Transmit/ Receive (Directional) Coupling
TRF/PA – Transmit RF/Power amplifier
RRF/LNA – Receive RF/Low Noise Amplifier

Fig. 9

Fig. 10

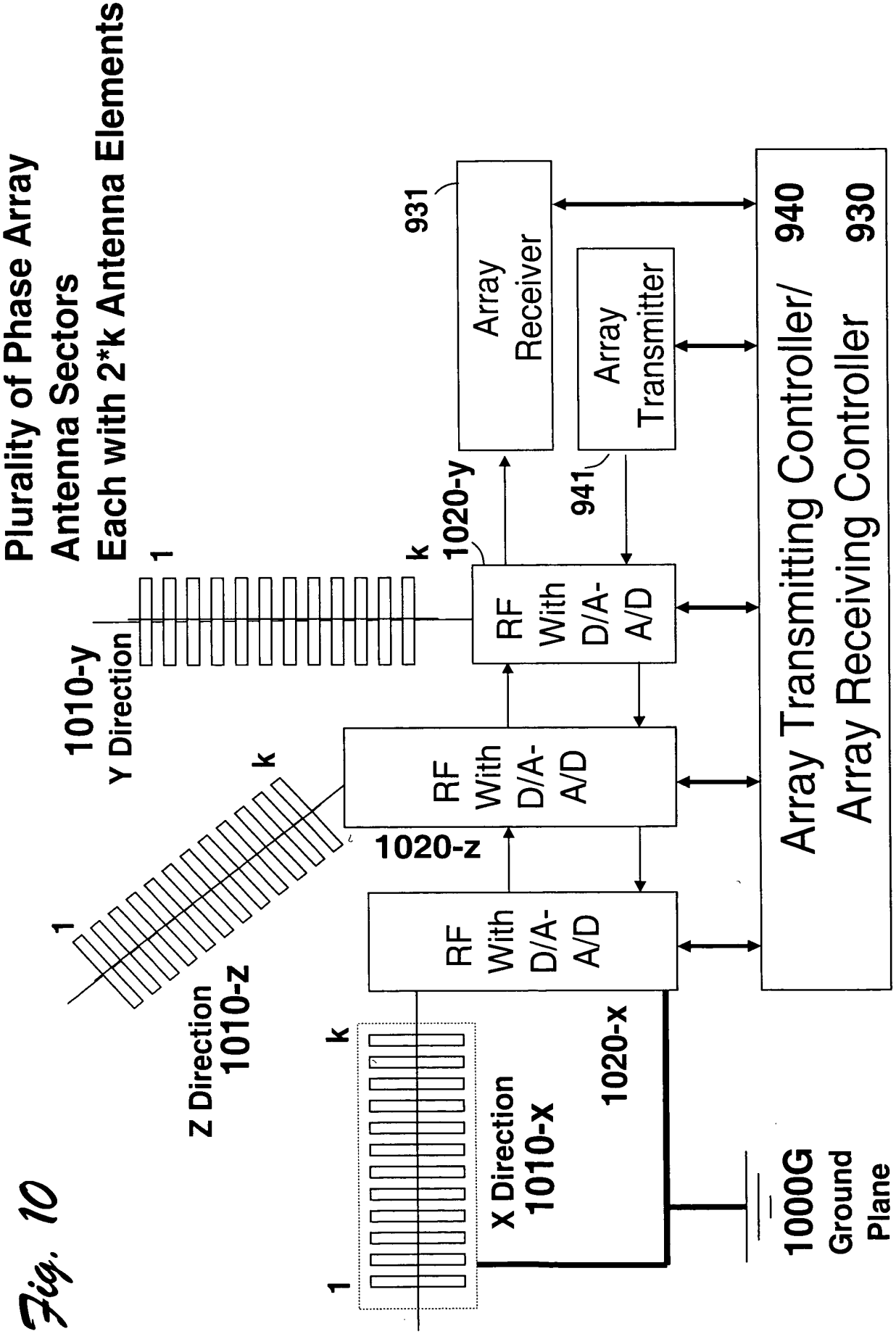

Plurality of Phase Array Antenna Sectors Each with 2*k Antenna Elements
1010-y
Y Direction
1
k
1020-y
931
Array Receiver
941
Array Transmitter
RF With D/A-A/D
1020-z
Z Direction
1010-z
1020-x
X Direction
1010-x
Array Transmitting Controller/ Array Receiving Controller
940
930
1000G
Ground Plane

Fig. 11

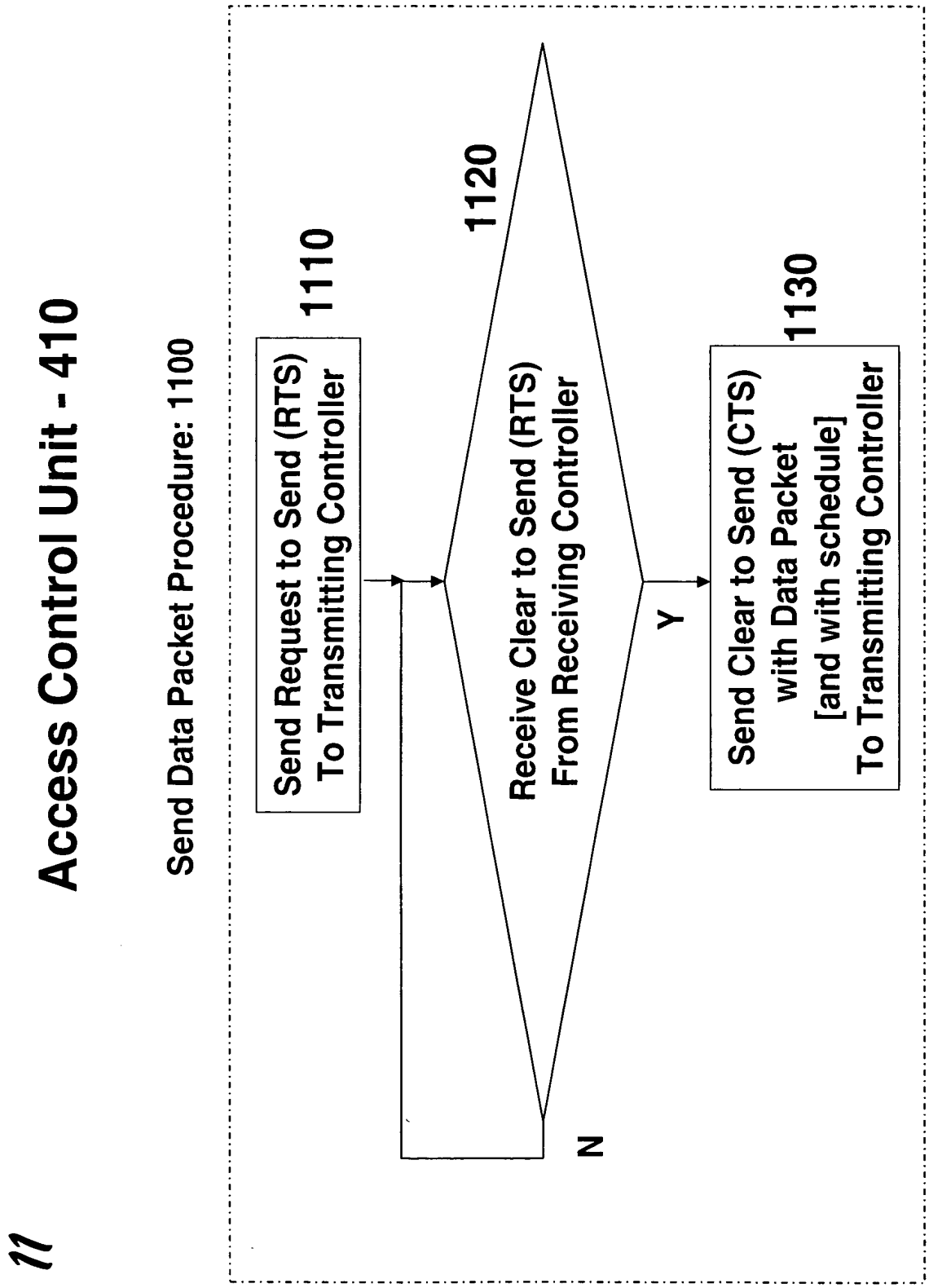

Access Control Unit - 410
Send Data Packet Procedure: 1100
Send Request to Send (RTS) To Transmitting Controller
1110
Receive Clear to Send (RTS) From Receiving Controller
1120
Y
N
Send Clear to Send (CTS) with Data Packet [and with schedule] To Transmitting Controller
1130

Fig. 12

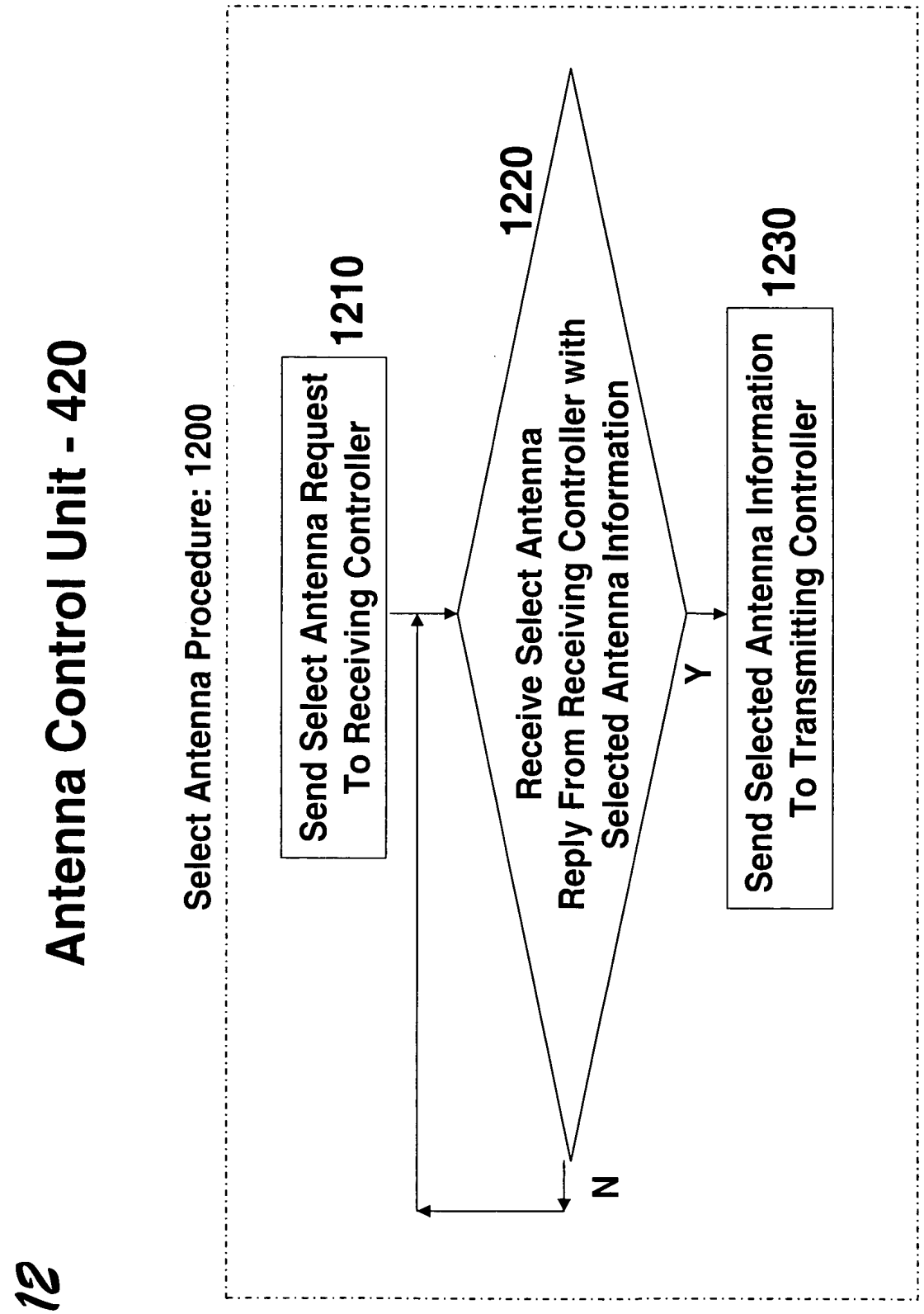

Antenna Control Unit - 420
Select Antenna Procedure: 1200
Send Select Antenna Request To Receiving Controller
1210
Receive Select Antenna Reply From Receiving Controller with Selected Antenna Information
1220
Y
N
Send Selected Antenna Information To Transmitting Controller
1230

Fig. 13

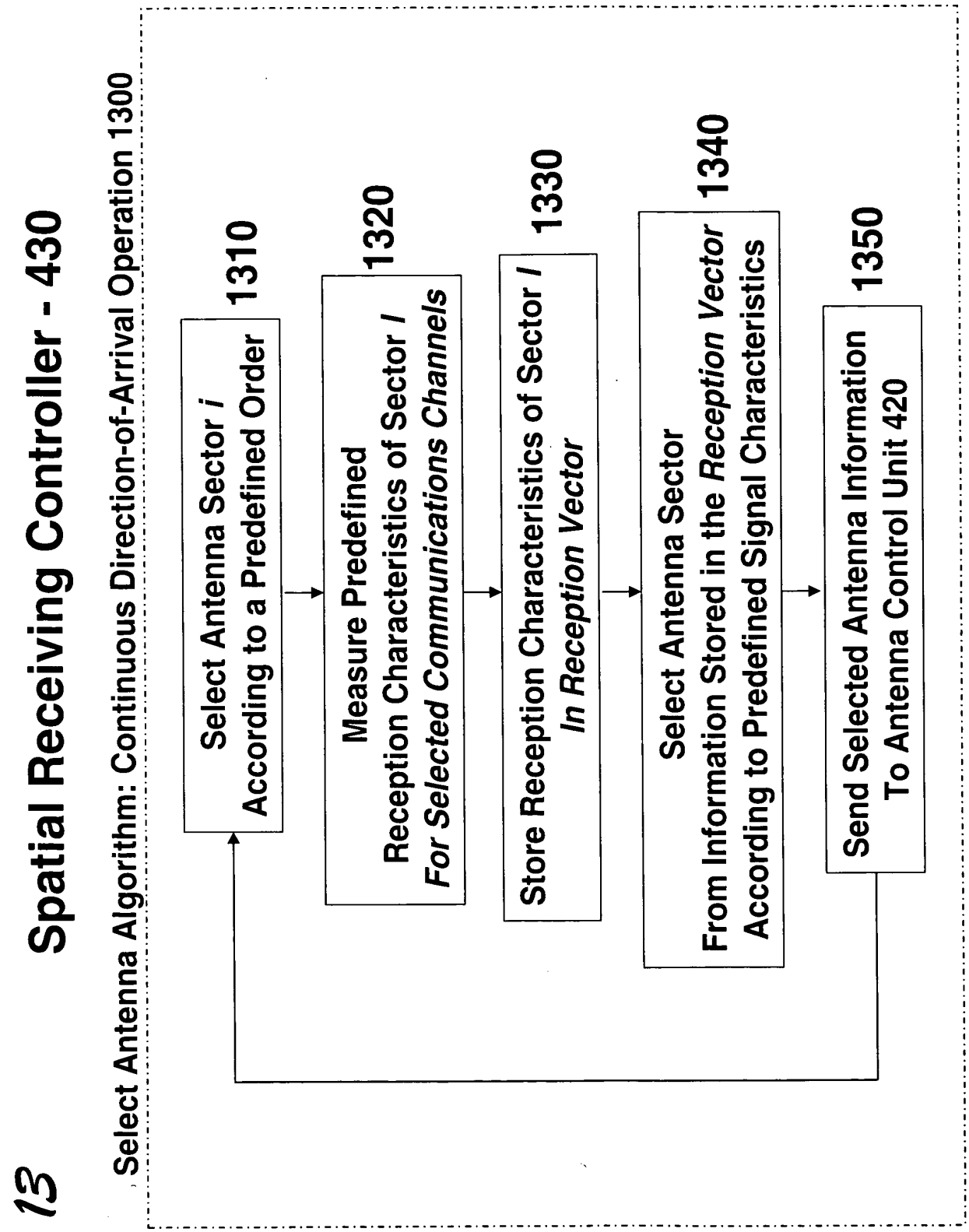

Spatial Receiving Controller - 430
Select Antenna Algorithm: Continuous Direction-of-Arrival Operation 1300
Select Antenna Sector *i* According to a Predefined Order
1310
Measure Predefined Reception Characteristics of Sector *I* *For Selected Communications Channels*
1320
Store Reception Characteristics of Sector *I* *In Reception Vector*
1330
Select Antenna Sector From Information Stored in the *Reception Vector* According to Predefined Signal Characteristics
1340
Send Selected Antenna Information To Antenna Control Unit 420
1350

Fig. 14

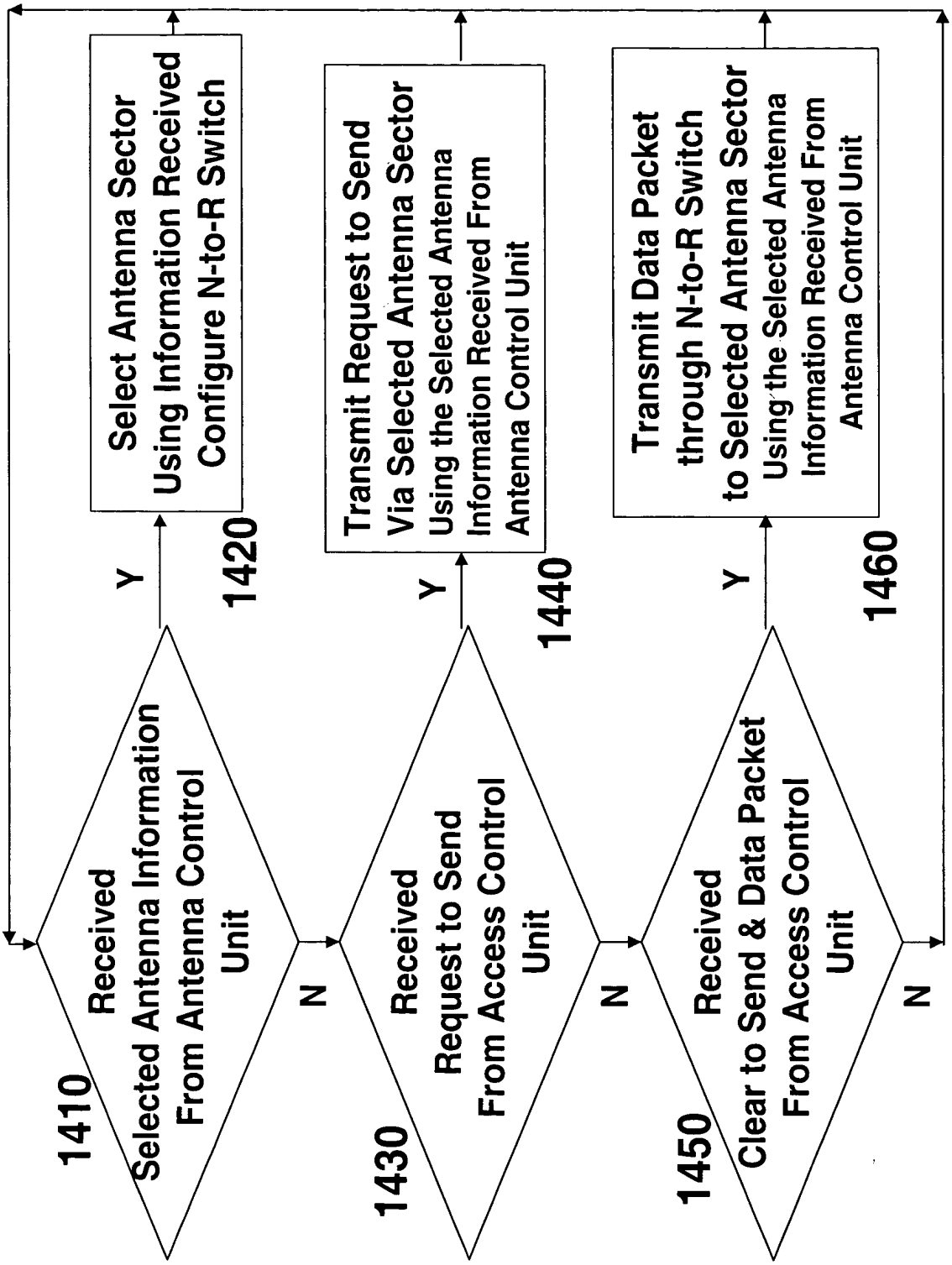

Spatial Transmitting Controller - 440
1410
Received Selected Antenna Information From Antenna Control Unit
Y
Select Antenna Sector Using Information Received Configure N-to-R Switch
1420
N
1430
Received Request to Send From Access Control Unit
Y
Transmit Request to Send Via Selected Antenna Sector Using the Selected Antenna Information Received From Antenna Control Unit
1440
N
1450
Received Clear to Send & Data Packet From Access Control Unit
Y
Transmit Data Packet through N-to-R Switch to Selected Antenna Sector Using the Selected Antenna Information Received From Antenna Control Unit
1460
N

Fig. 15

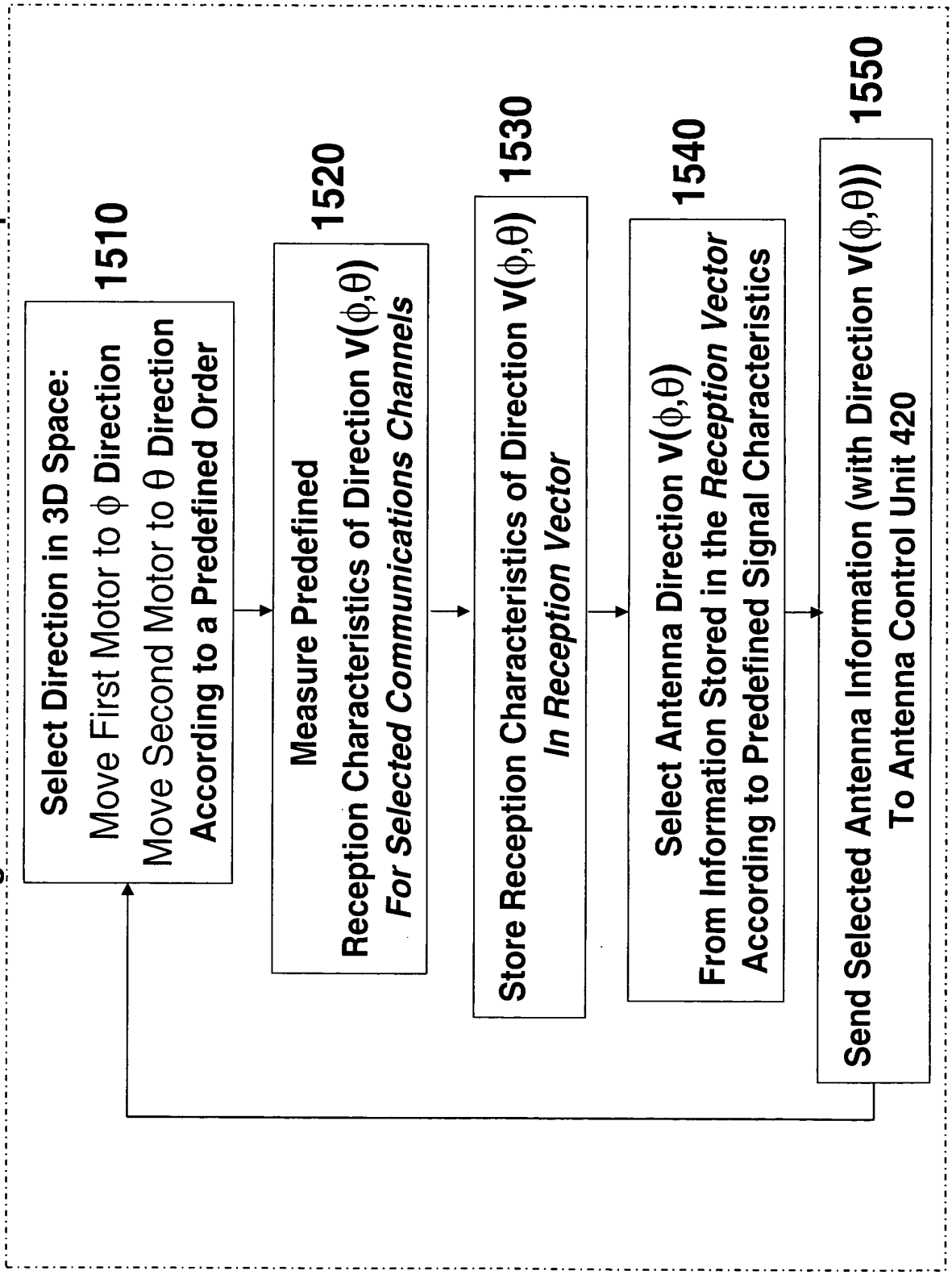

Moveable Receiving Controller – 730
Select Direction Algorithm: Continuous Direction-of-Arrival Operation 1500
Select Direction in 3D Space:
Move First Motor to ϕ Direction
Move Second Motor to θ Direction
According to a Predefined Order
1510
Measure Predefined
Reception Characteristics of Direction V(ϕ,θ)
For Selected Communications Channels
1520
Store Reception Characteristics of Direction V(ϕ,θ)
In Reception Vector
1530
Select Antenna Direction V(ϕ,θ)
From Information Stored in the Reception Vector
According to Predefined Signal Characteristics
1540
Send Selected Antenna Information (with Direction V(ϕ,θ))
To Antenna Control Unit 420
1550

Fig. 16

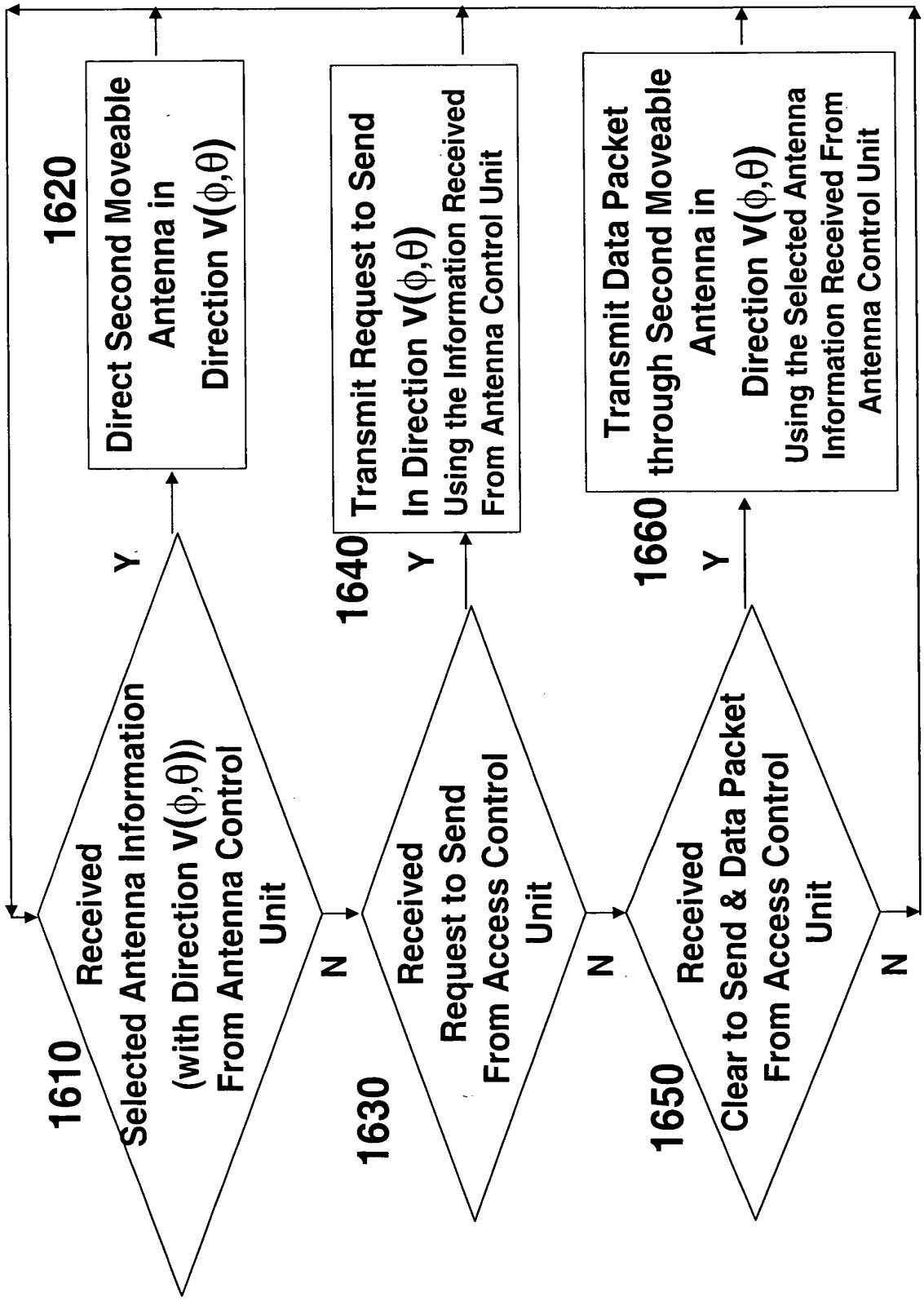

Moveable Transmitting Controller - 740
1610
Received Selected Antenna Information (with Direction V(ϕ,θ)) From Antenna Control Unit
Y
N
1620
Direct Second Moveable Antenna in Direction V(ϕ,θ)
1630
Received Request to Send From Access Control Unit
Y
N
1640
Transmit Request to Send In Direction V(ϕ,θ) Using the Information Received From Antenna Control Unit
1650
Received Clear to Send & Data Packet From Access Control Unit
Y
N
1660
Transmit Data Packet through Second Moveable Antenna in Direction V(ϕ,θ) Using the Selected Antenna Information Received From Antenna Control Unit

Fig. 17

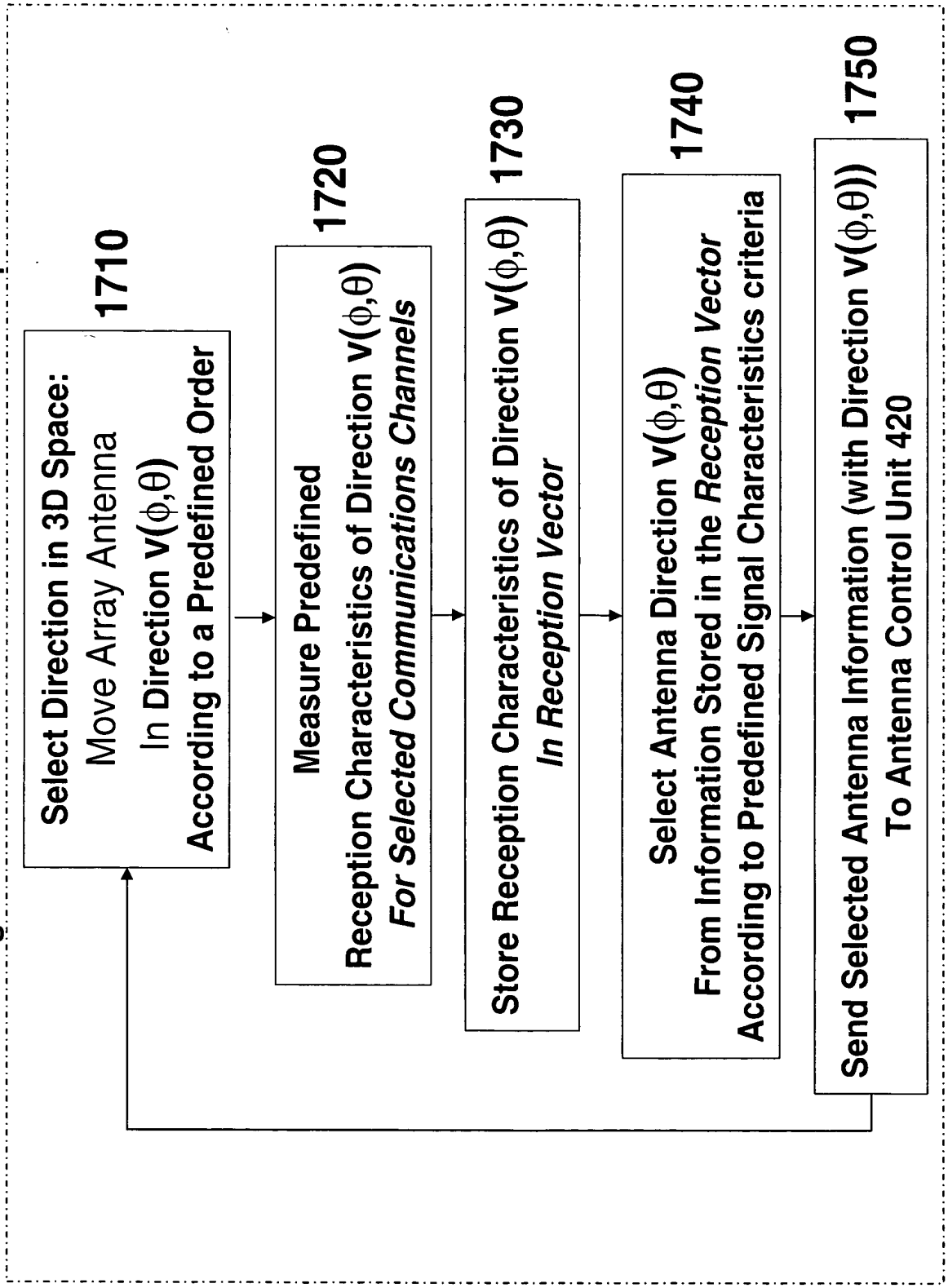

Array Receiving Controller - 930
Select Direction Algorithm: Continuous Direction-of-Arrival Operation 1700
Select Direction in 3D Space:
Move Array Antenna
In Direction V(ϕ,θ)
According to a Predefined Order
1710
Measure Predefined
Reception Characteristics of Direction V(ϕ,θ)
For Selected Communications Channels
1720
Store Reception Characteristics of Direction V(ϕ,θ)
In Reception Vector
1730
Select Antenna Direction V(ϕ,θ)
From Information Stored in the Reception Vector
According to Predefined Signal Characteristics criteria
1740
Send Selected Antenna Information (with Direction V(ϕ,θ))
To Antenna Control Unit 420
1750

Fig. 18

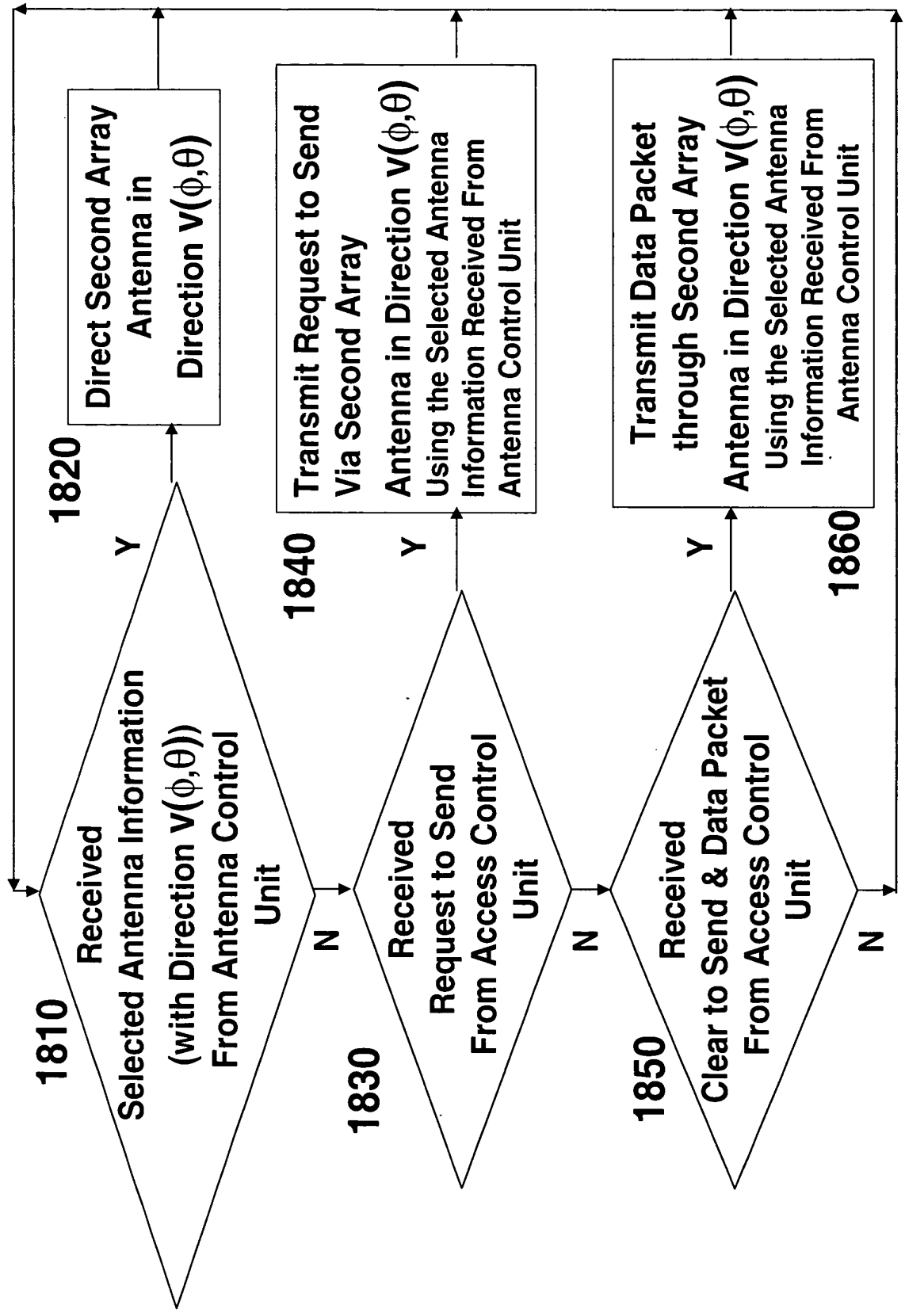

Array Transmitting Controller - 940
1810
Received Selected Antenna Information (with Direction V(ϕ,θ)) From Antenna Control Unit
Y
1820
Direct Second Array Antenna in Direction V(ϕ,θ)
N
1830
Received Request to Send From Access Control Unit
Y
1840
Transmit Request to Send Via Second Array Antenna in Direction V(ϕ,θ) Using the Selected Antenna Information Received From Antenna Control Unit
N
1850
Received Clear to Send & Data Packet From Access Control Unit
Y
Transmit Data Packet through Second Array Antenna in Direction V(ϕ,θ) Using the Selected Antenna Information Received From Antenna Control Unit
1860
N

Fig. 19

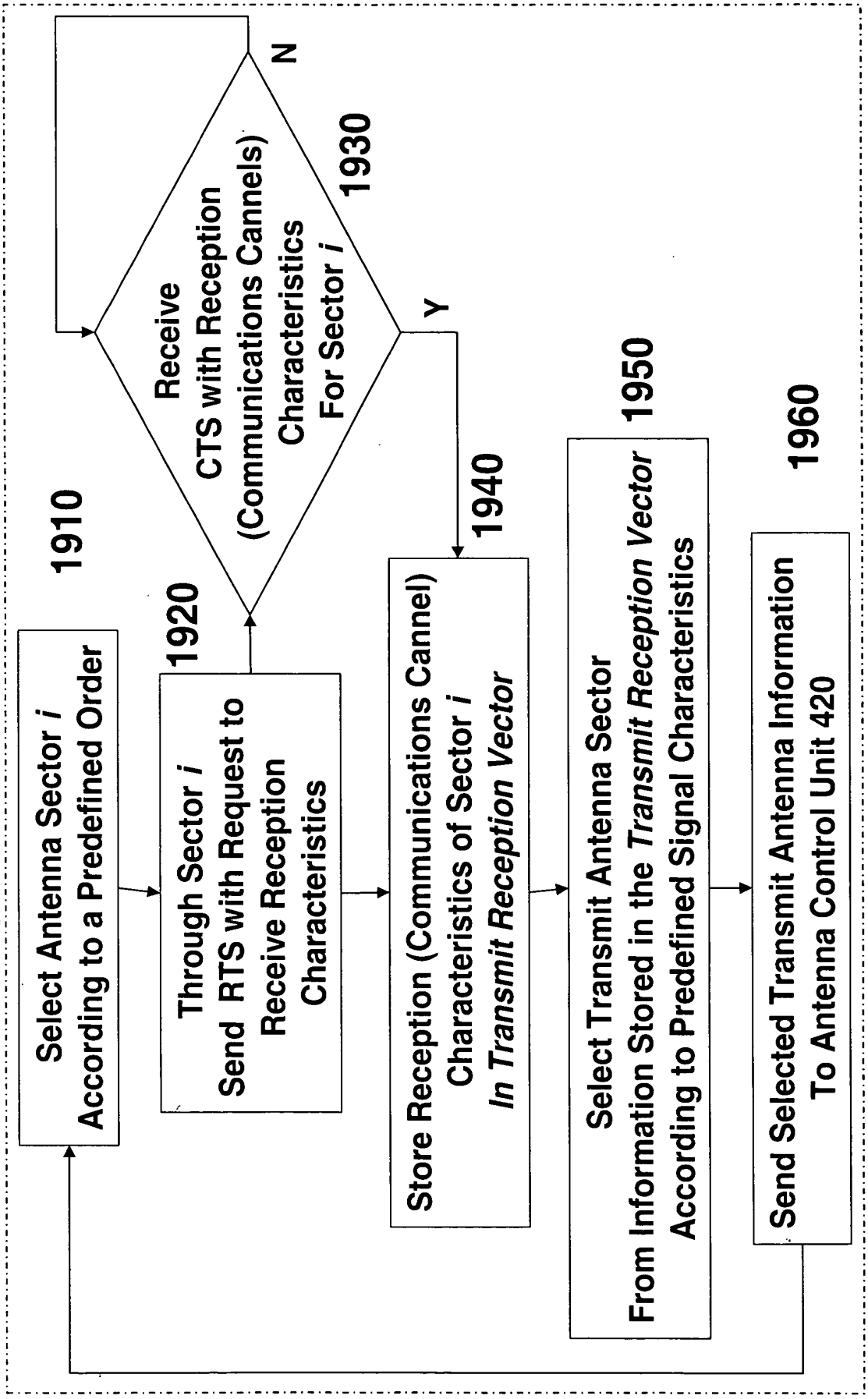

End (Mobile) Device Transmits and Receives
on Different Frequencies – Selecting Transmit Antenna Sector
Select Antenna Sector i
According to a Predefined Order
1910
Through Sector i
Send RTS with Request to
Receive Reception
Characteristics
1920
Receive
CTS with Reception
(Communications Cannels)
Characteristics
For Sector i
1930
N
Y
Store Reception (Communications Cannel)
Characteristics of Sector i
In Transmit Reception Vector
1940
Select Transmit Antenna Sector
From Information Stored in the Transmit Reception Vector
According to Predefined Signal Characteristics
1950
Send Selected Transmit Antenna Information
To Antenna Control Unit 420
1960

Fig. 20

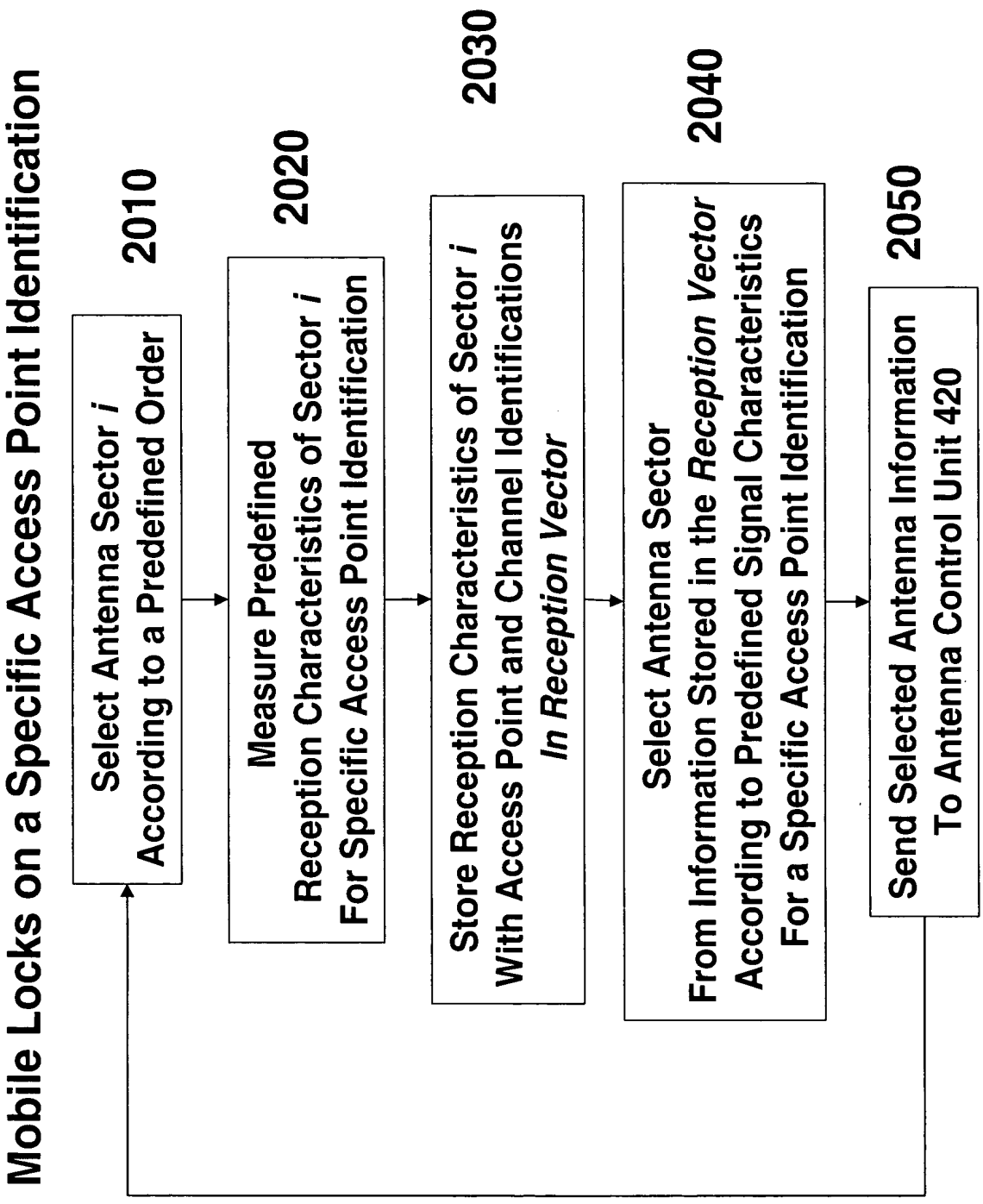
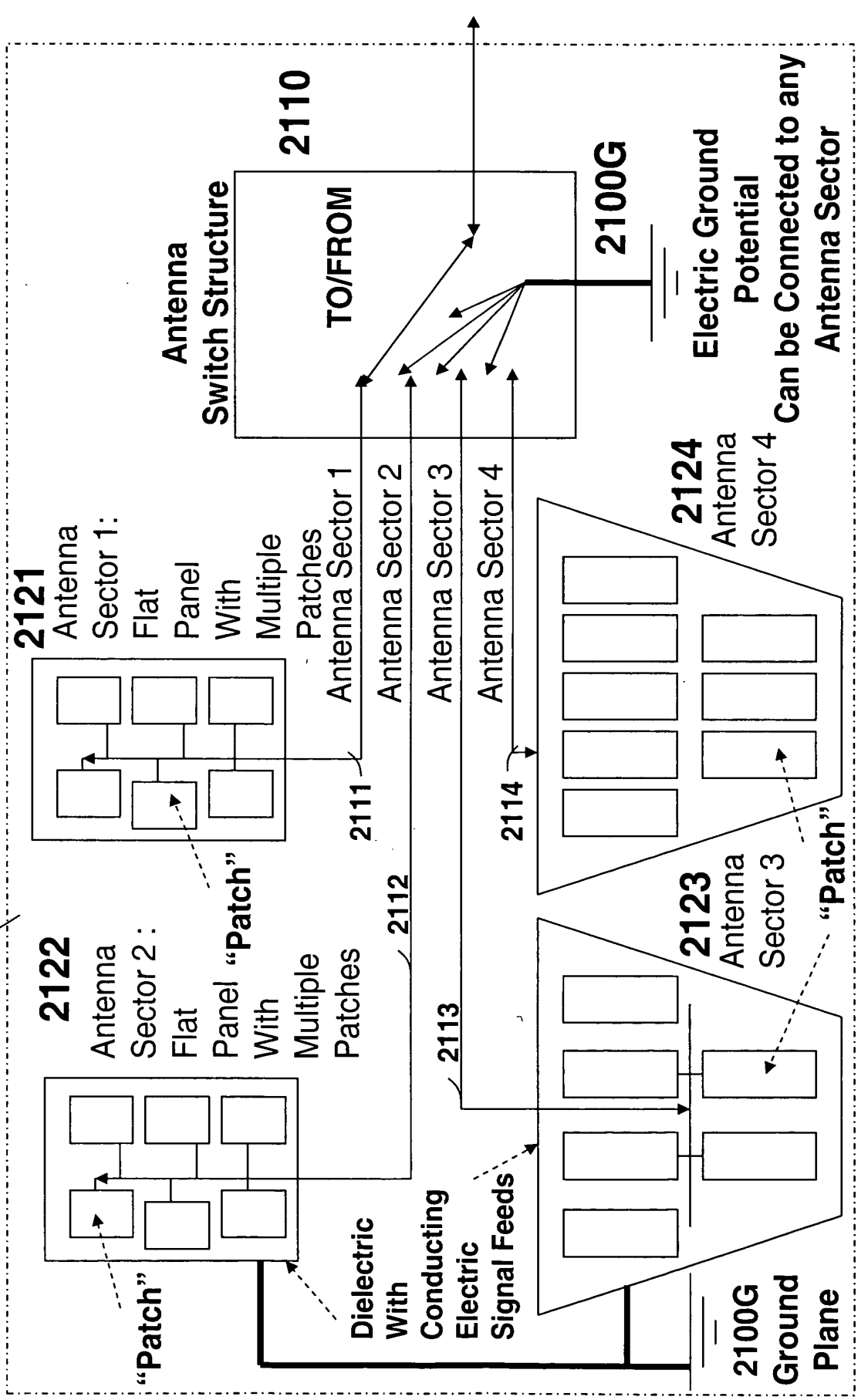

Mobile Locks on a Specific Access Point Identification
Select Antenna Sector *i* According to a Predefined Order
2010
Measure Predefined Reception Characteristics of Sector *i* For Specific Access Point Identification
2020
Store Reception Characteristics of Sector *i* With Access Point and Channel Identifications *In Reception Vector*
2030
Select Antenna Sector From Information Stored in the *Reception Vector* According to Predefined Signal Characteristics For a Specific Access Point Identification
2040
Send Selected Antenna Information To Antenna Control Unit 420
2050

Fig. 21


2 Directional Flat Panel and 2 Directional / Polarized Planar Array Antenna Sectors
150
2121 Antenna Sector 1: Flat Panel With Multiple Patches
2122 Antenna Sector 2 : Flat Panel With Multiple Patches
2123 Antenna Sector 3
2124 Antenna Sector 4
Antenna Switch Structure
2110
TO/FROM
2100G
Electric Ground Potential
Can be Connected to any Antenna Sector
Antenna Sector 1
Antenna Sector 2
Antenna Sector 3
Antenna Sector 4
2111
2112
2113
2114
"Patch"
"Patch"
"Patch"
Dielectric With Conducting Electric Signal Feeds
2100G Ground Plane

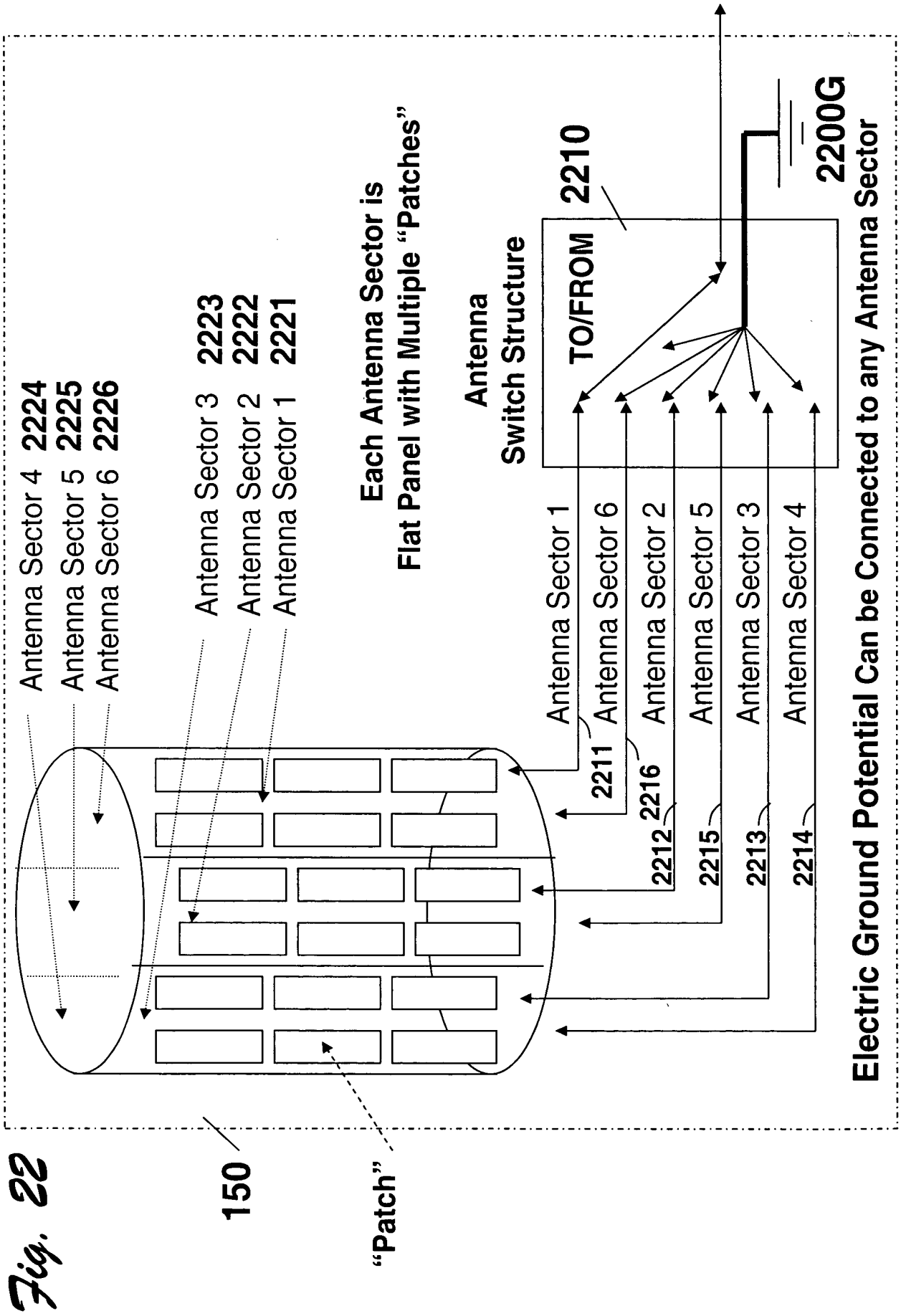
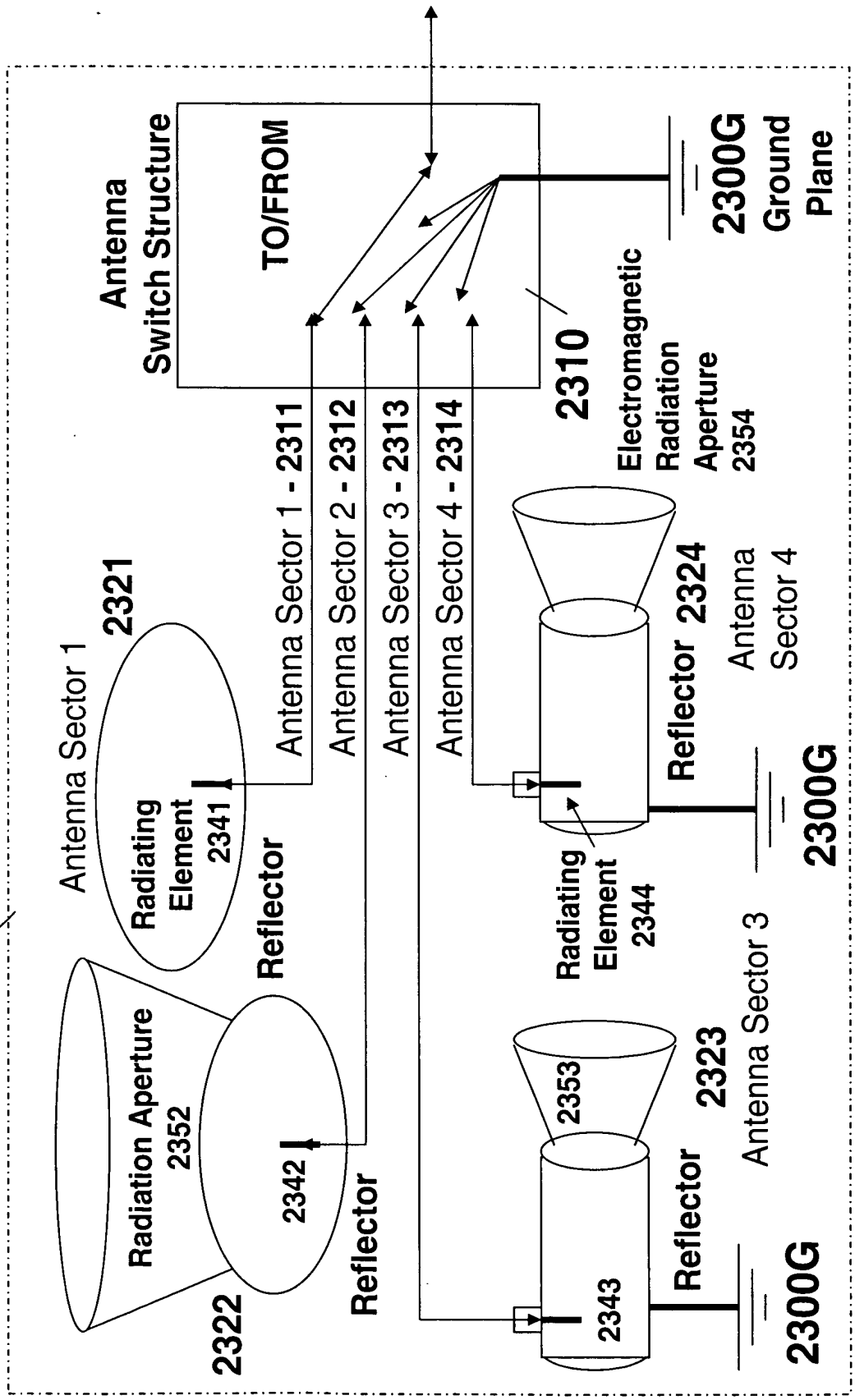

Antenna Sector 4 2224
Antenna Sector 5 2225
Antenna Sector 6 2226
Antenna Sector 3 2223
Antenna Sector 2 2222
Antenna Sector 1 2221
Each Antenna Sector is
Flat Panel with Multiple "Patches"
Antenna
Switch Structure
TO/FROM
2210
2200G
Electric Ground Potential Can be Connected to any Antenna Sector
Antenna Sector 1
Antenna Sector 6
Antenna Sector 2
Antenna Sector 5
Antenna Sector 3
Antenna Sector 4
2211
2216
2212
2215
2213
2214
150
"Patch"

Fig. 22

Fig. 23


4 Directional
Parabolic-dish-reflector or Yagi/Tube-like
Antenna Sectors
150
Antenna
Switch Structure
TO/FROM
2310
Electromagnetic
Radiation
Aperture
2354
2300G
Ground
Plane
Antenna Sector 1 - 2311
Antenna Sector 2 - 2312
Antenna Sector 3 - 2313
Antenna Sector 4 - 2314
Antenna Sector 1
2321
Radiating
Element
2341
Reflector
Radiation Aperture
2352
2322
2342
Reflector
Radiating
Element
2344
Reflector 2324
Antenna
Sector 4
2300G
2353
2343
Reflector
2323
Antenna Sector 3
2300G

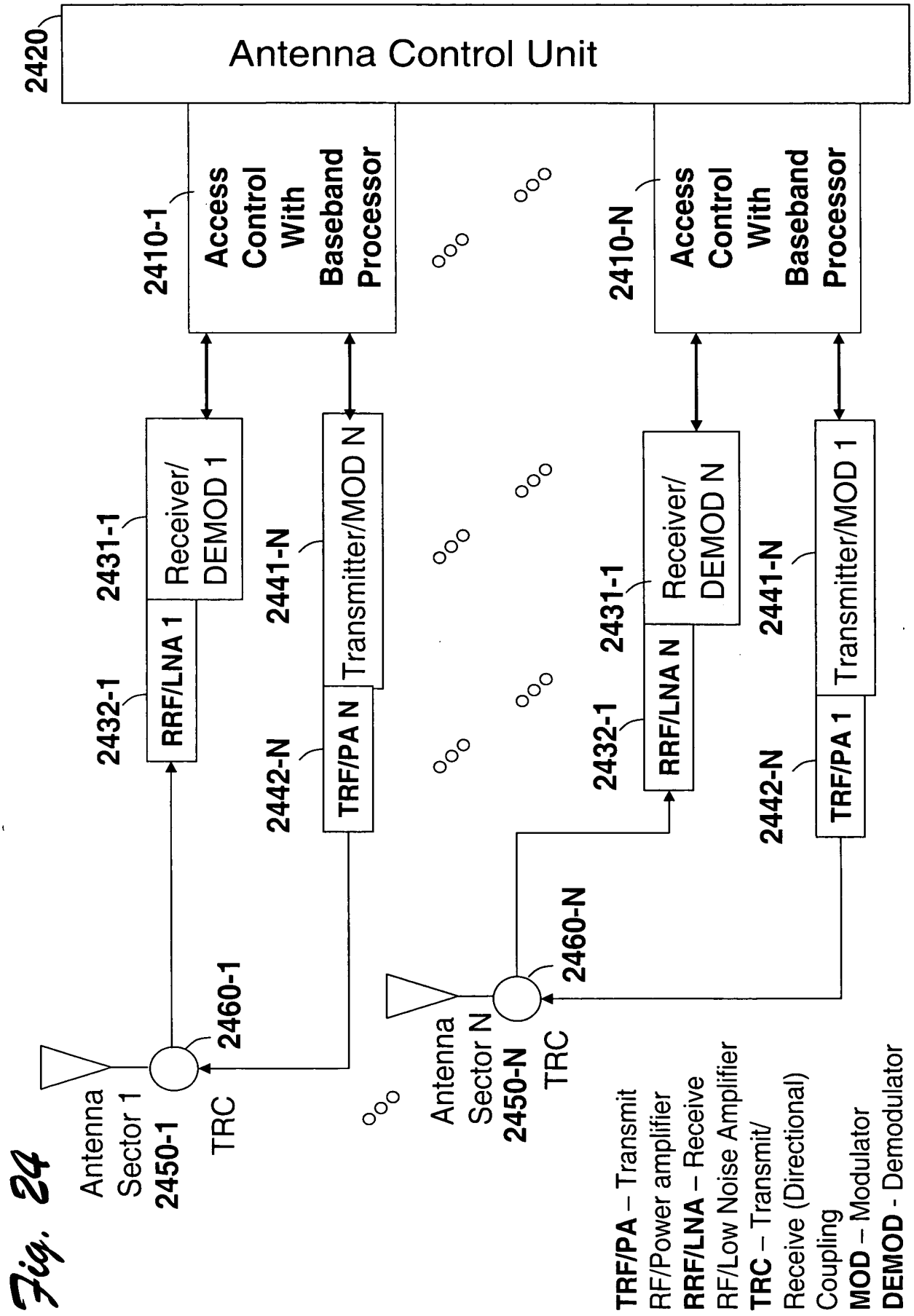

2420
Antenna Control Unit
2410-1
Access Control With Baseband Processor
2410-N
Access Control With Baseband Processor
2431-1
Receiver/ DEMOD 1
2441-N
Transmitter/MOD N
2432-1
RRF/LNA 1
2442-N
TRF/PA N
2431-1
Receiver/ DEMOD N
2441-N
Transmitter/MOD 1
2432-1
RRF/LNA N
2442-N
TRF/PA 1
Antenna Sector 1
2450-1
TRC
2460-1
Antenna Sector N
2450-N
TRC
2460-N
TRF/PA – Transmit RF/Power amplifier
RRF/LNA – Receive RF/Low Noise Amplifier
TRC – Transmit/ Receive (Directional) Coupling
MOD – Modulator
DEMOD - Demodulator

Fig. 24

Fig. 25

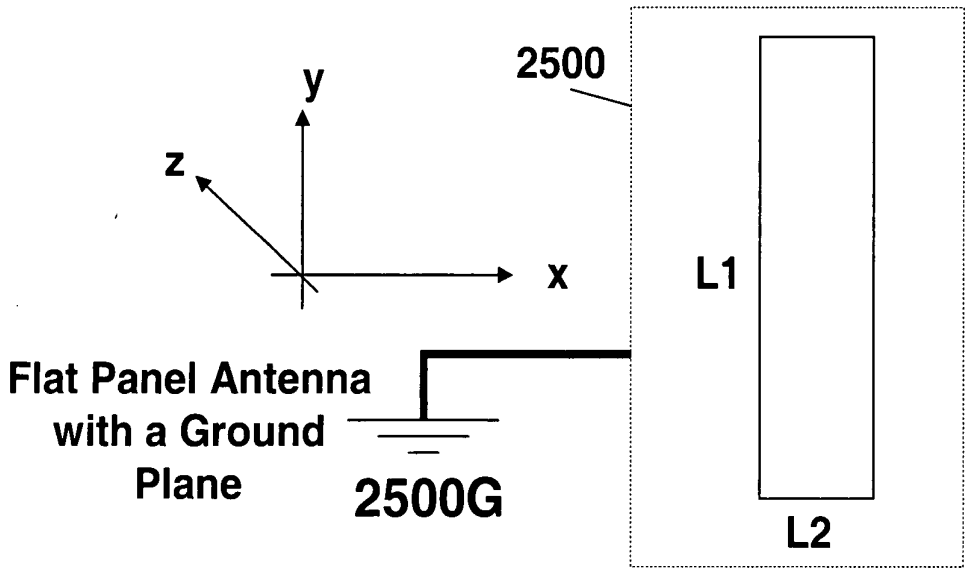
Flat Panel Antenna Sector Design

2511. $g_{max} \approx 4*(3.14)*\{(L1*L2)/(Lambda^2)\}$ **[Lambda = speed-of-light/Frequency]**
[A=L1*L2 is the rectangular area of **antenna aperture** in cm ^{2}]

2512. Lambda/L1 and Lambda/L2 are the beam widths –
in radians (57.3 degrees)

Aperture

2513. Antenna Gain: $G(db) = 10 \log_{10}(g_{max}) \approx 10 \log_{10} [12.5*A / Lambda^2]$



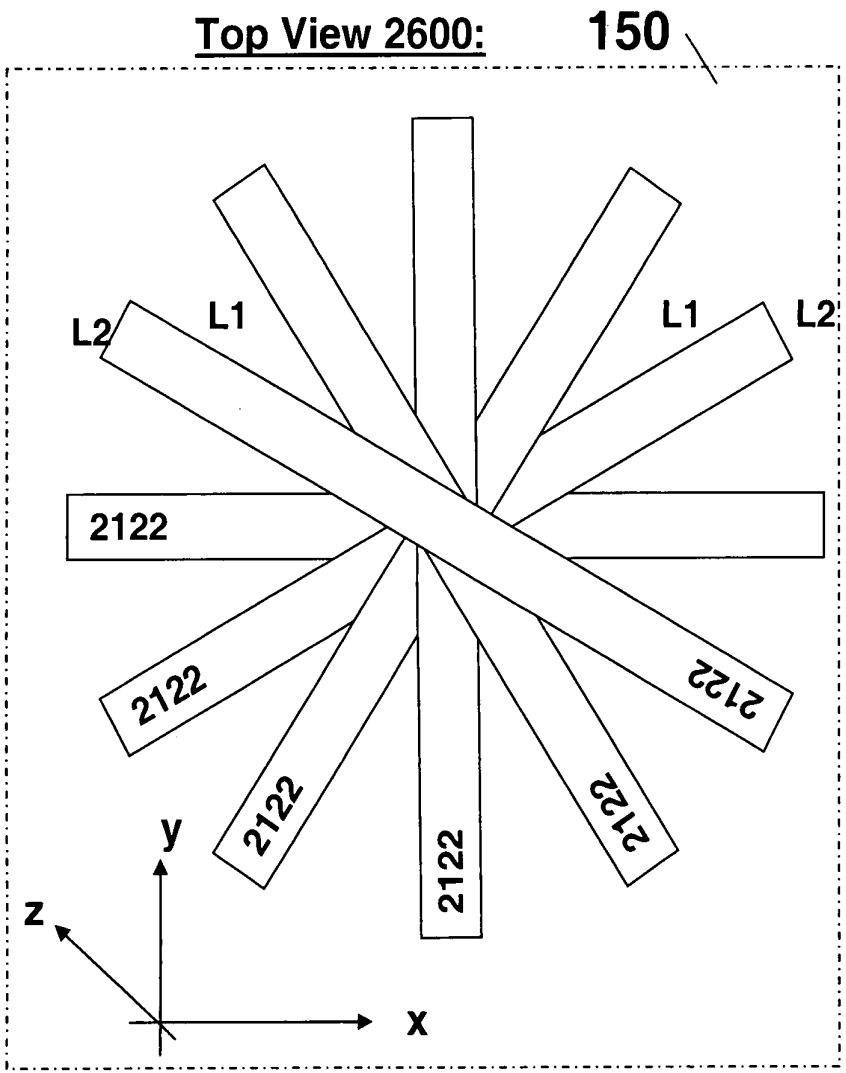
L1-by-L2
Flat Panel Antenna Sector
Wherein:
- **L1 is in the x-y plane**
- **L2 is in the z direction – 90 degree with respect to to the x-y plane**

However:
- **L1 may be tilted in the z direction**
- **L2 may be tilted in a defined angle with respect to the x-y plane**

Fig. 26

Plurality of Vertically Stackable Flat Panel Antenna Sectors

- Each sector consists of plurality of "patches" may be tilted along L1 and/or L2
- Ground and dielectric planes are not shown



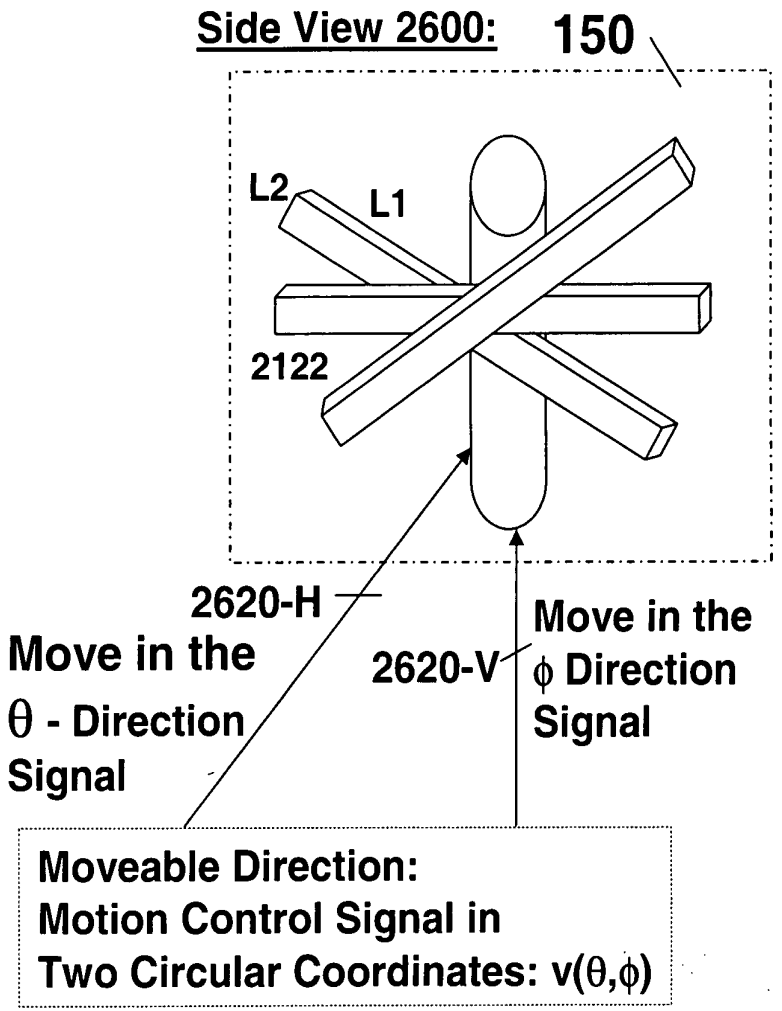


Fig. 27

Plurality of Vertically Stackable Tube-like/Yagi Antenna Sectors

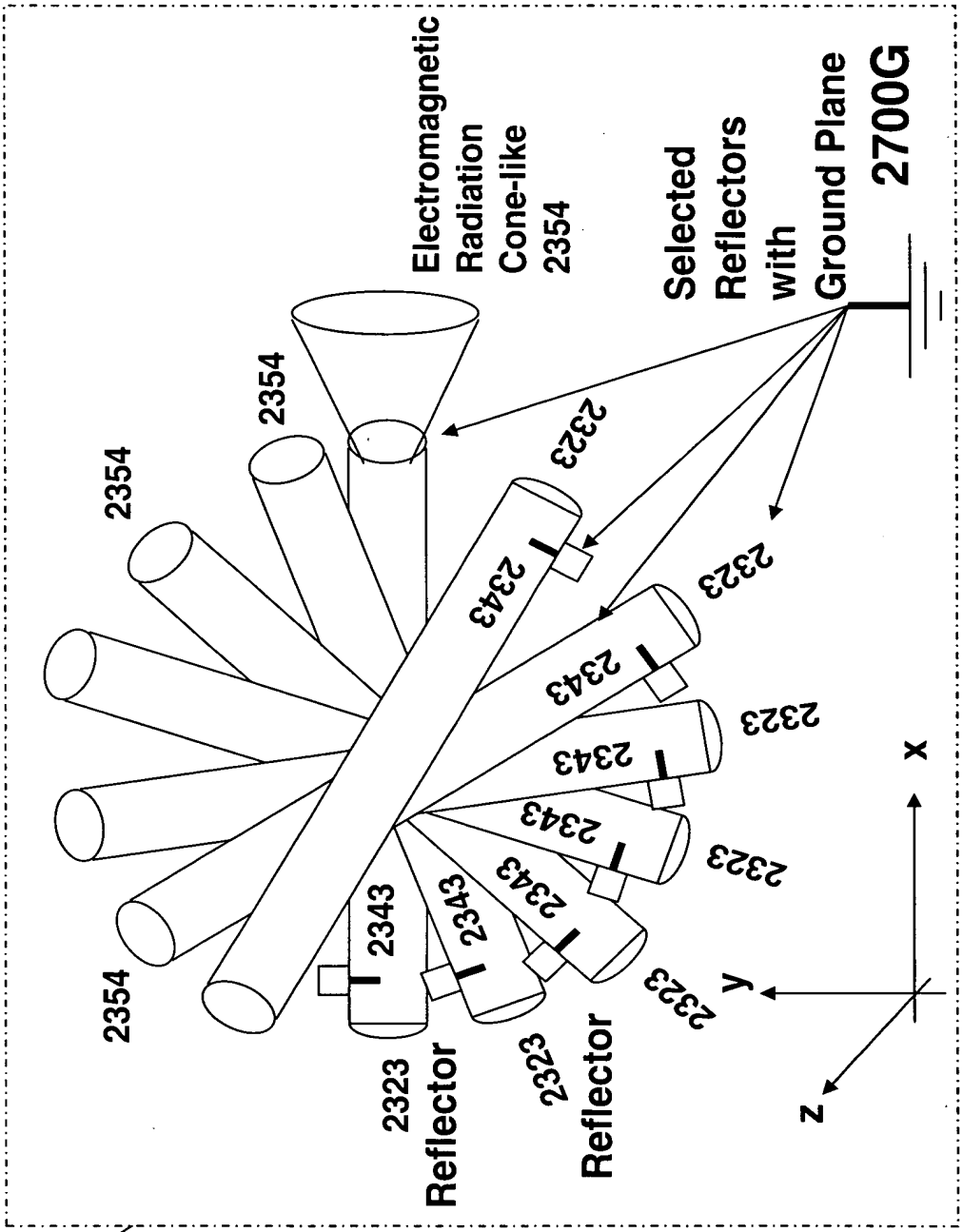


Fig. 28

Flat Panel Antenna Sector

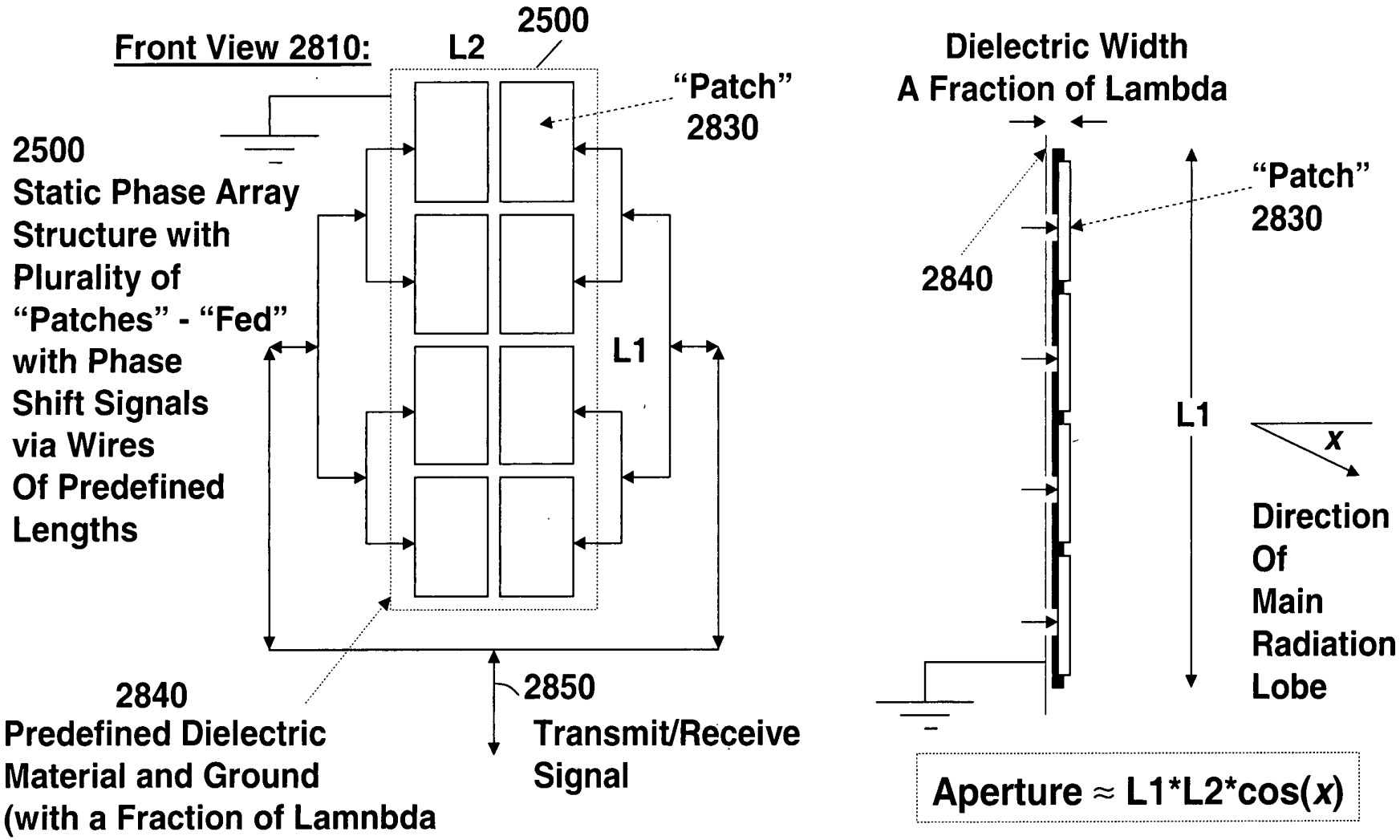


Fig. 29

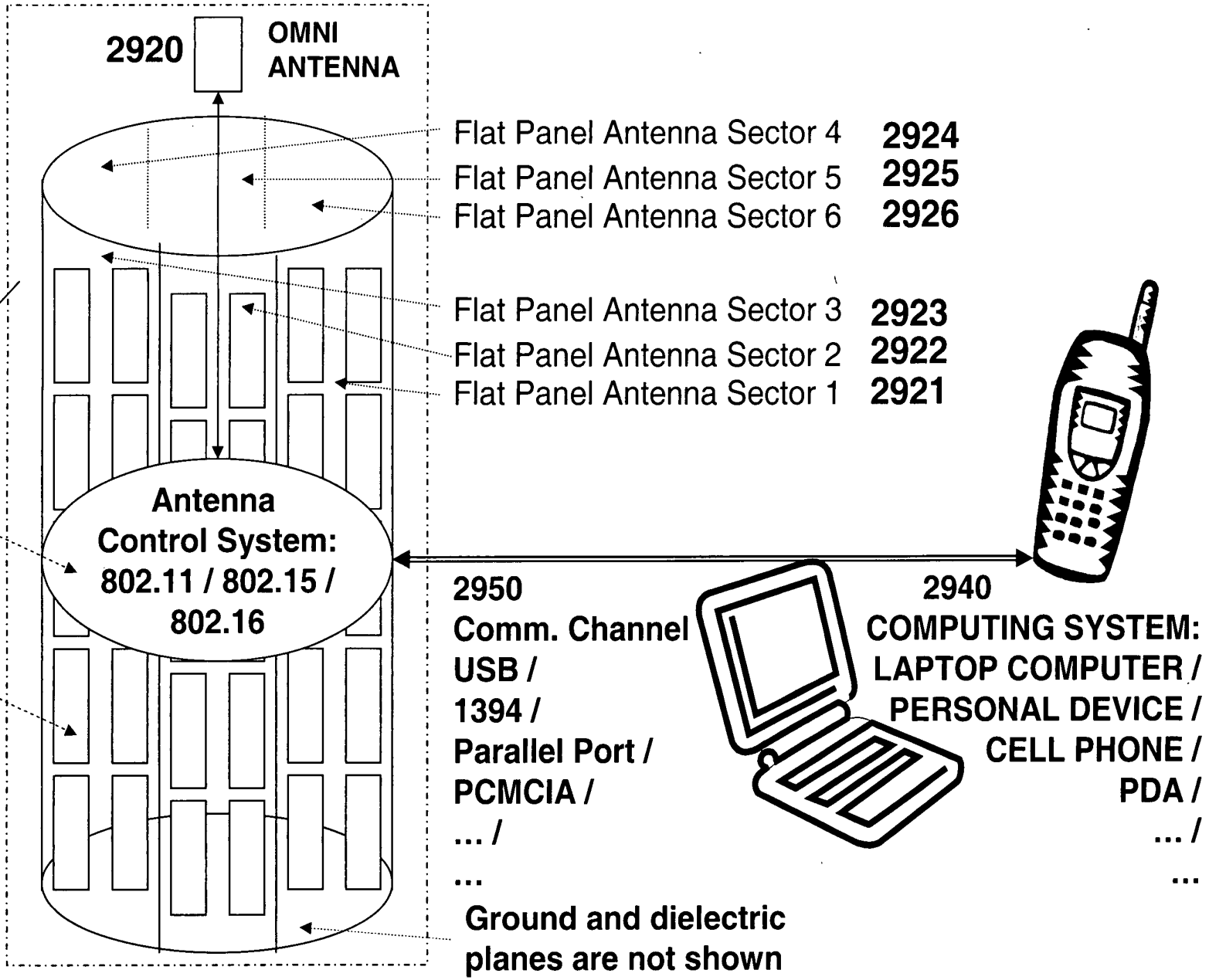

2920
OMNI ANTENNA
Flat Panel Antenna Sector 4 2924
Flat Panel Antenna Sector 5 2925
Flat Panel Antenna Sector 6 2926
Flat Panel Antenna Sector 3 2923
Flat Panel Antenna Sector 2 2922
Flat Panel Antenna Sector 1 2921
2900 and 150/160 in Figs. 1-2
2930
Antenna Control System: 802.11 / 802.15 / 802.16
"Patch" 2810
2950
Comm. Channel
USB /
1394 /
Parallel Port /
PCMCIA /
... /
...
2940
COMPUTING SYSTEM:
LAPTOP COMPUTER /
PERSONAL DEVICE /
CELL PHONE /
PDA /
... /
...
Ground and dielectric planes are not shown

Fig. 30

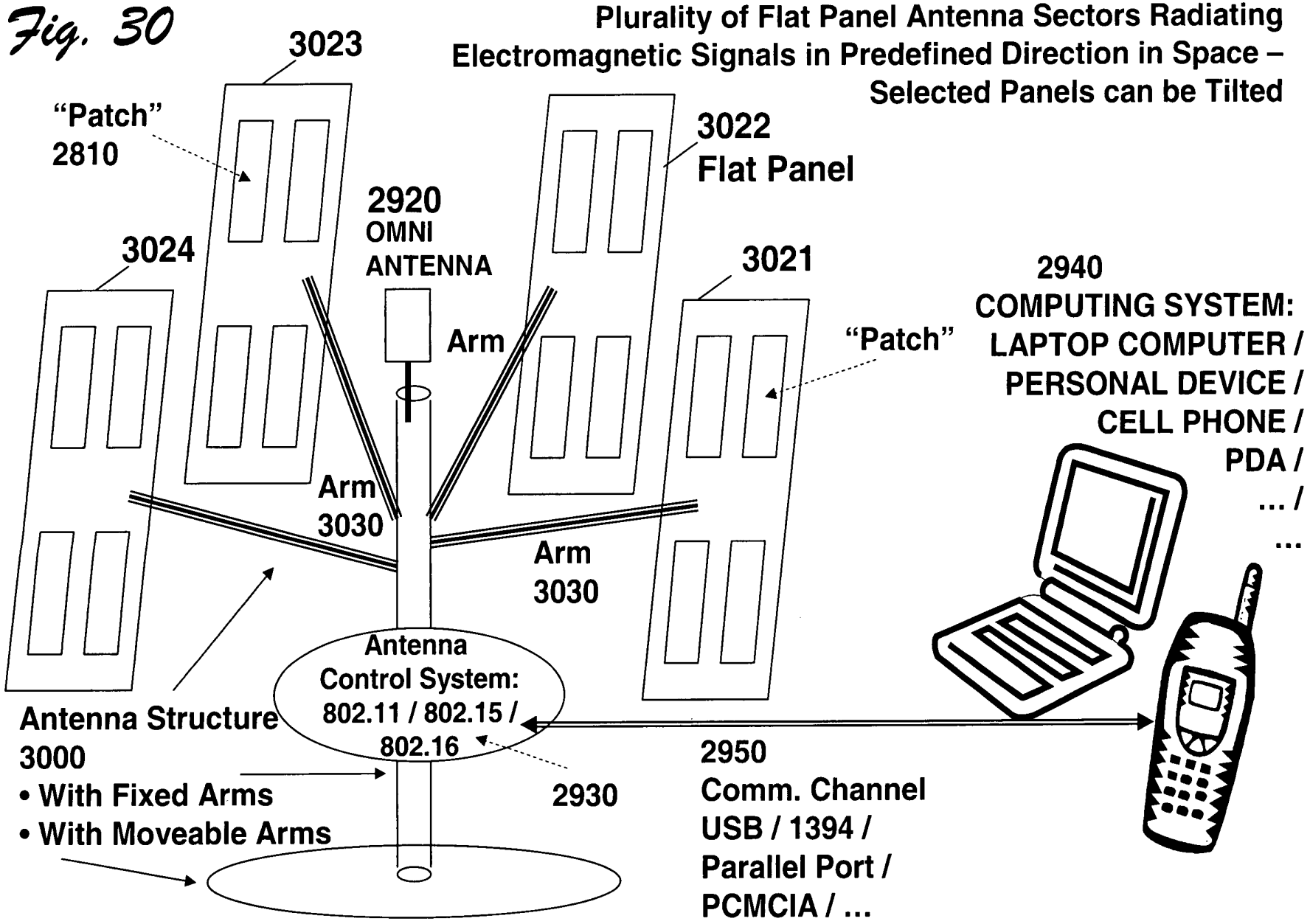
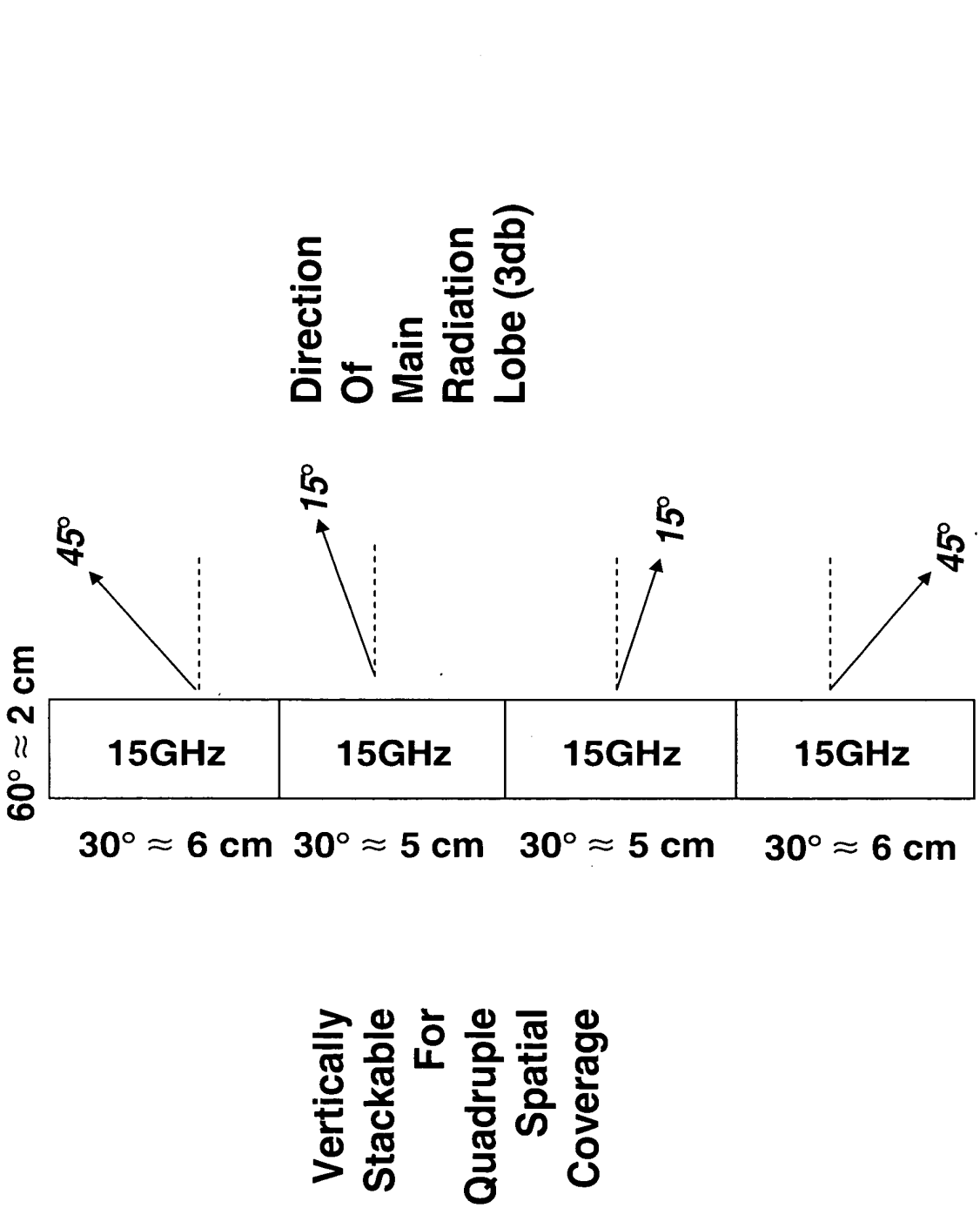

Plurality of Flat Panel Antenna Sectors Radiating Electromagnetic Signals in Predefined Direction in Space – Selected Panels can be Tilted
3023
"Patch" 2810
3022 Flat Panel
2920 OMNI ANTENNA
3024
3021
Arm
"Patch"
2940 COMPUTING SYSTEM: LAPTOP COMPUTER / PERSONAL DEVICE / CELL PHONE / PDA / ... / ...
Arm 3030
Arm 3030
Antenna Control System: 802.11 / 802.15 / 802.16
Antenna Structure 3000
• With Fixed Arms
• With Moveable Arms
2930
2950 Comm. Channel USB / 1394 / Parallel Port / PCMCIA / ...

Fig. 31


A Vertical Slice of Cylindrical Shape Structure
(6 Vertical Slices with Hexagonal Arrangement for Covering 360°)
Direction Of Main Radiation Lobe (3db)
45°
15°
15°
45°
60° ≈ 2 cm
15GHz
15GHz
15GHz
15GHz
30° ≈ 6 cm
30° ≈ 5 cm
30° ≈ 5 cm
30° ≈ 6 cm
Vertically Stackable For Quadruple Spatial Coverage